Burnt Corral Vegetation Management Project
Environmental Analysis
Vegetation Resources Specialist Report
Kaibab National Forest
North Kaibab Ranger District

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BACKGROUND

The Burnt Corral Vegetation Management Project would be the first in a series of activities to restore forest health, beneficial fire regimes, and wildlife habitat in the ponderosa pine belt on the west side of the Kaibab Plateau. The project was visualized from the 2009 Kaibab Forest Health Focus (KFHF), a collaborative landscape assessment that identified priority management areas on the Kaibab National Forest, and with guidance and direction from the Kaibab NF Land and Resources Management Plan (2014).

The main goal of this effort is to improve forest health and vigor, while enhancing habitat conditions resilient to wildfire and/or other climatic disturbance events. The project was a collaborative effort with diverse stakeholders to reach a consensus on forest management in the Burnt Corral area.

The Burnt Corral project area, about 28,090 acres in size, is located within the southwest portion of the Kaibab Plateau, south-southwest of Lookout Canyon and Forest Service Road (FSR) 22, on the North Kaibab Ranger District (NKRD), of the Kaibab National Forest (KNF). The project is in Townships 35-37 North, Ranges 1 West -1 East, in Coconino County, Arizona, Gila and Salt River Baseline and Meridian. Within the project area, most of the ponderosa pine vegetation type is located west of FSR 22, with the project area bounded by FSR 447 to the north, FSR 226 to the east, FSR 203/203A and FSR 425 to the south, and FSR425 and 427 to the west. See Appendix C, Project Area Map.

Project Area

The majority of the Burnt Corral (BC) project area falls within a Priority Landscape identified by the KFHF, comprising the western ponderosa pine belt of the Kaibab Plateau. This led the KNF to select Burnt Corral as the first phase of a larger, landscape-level restoration approach based on a collaborative, science-based assessment of forest composition and predicted fire behavior. The western edge of the Burnt Corral project corresponds to the ecotone between ponderosa pine forest and the pinyon juniper-oak woodland area, with about 7,520 acres in the west-northwest portion overlapping the 1996 Bridger Knoll Fire area. The Bridger Knoll Fire area is now dominated by patches of oak, New Mexico locust, and open areas supporting bunch grasses and other low-lying vegetation. There are also ponderosa pine plantations in the Bridger Fire area in Burnt Corral.

There was commercial, salvage logging and ponderosa pine reforestation (about 1,360 acres) during the late 1990's and early 2000's. The Bridger Knoll fire burned about 60,000 acres on the forest during the summer of 1996.

The Mill Fire (2008) area (1,710 acres) also lies within the northeast corner of the Burnt Corral planning area. There are about 360 acres of Mexican Spotted Owl Recovery Habitat in the Southeast corner of the project area. The project area is currently open to firewood gathering by permit.

Within the project area, the ponderosa pine forest vegetation community occurs at elevations ranging from 6,800 to 7,800 feet. Topography ranges from the flatter, higher elevation areas of the Kaibab Plateau, located in the eastern portion of the project area, to lower-elevation bench areas on the western side.

A large section of the forest within the Burnt Corral project area (approximately 21,200 acres) is

ponderosa pine type, and is usually denser and more contiguous than forest structures characteristic of reference conditions.

See Appendix C for a map of the vegetation types and corresponding acres in the BC project area.

Forest Plan

The Land and Resource Management Plan (Forest Plan, March 2014) for the Kaibab National Forest emphasizes restoring the ponderosa pine component on the North Kaibab, which has departed considerably from desired conditions. As a result, there is a priority need for change (see Forest Plan, pp. 16-20, 30-32, & 191-192). Management activities in ponderosa pine should attempt restoring forest structure, low-intensity fire, natural levels of disturbance, and nutrient cycling.

Design features may increase diversity within treatment areas by promoting aspen and oak (see Forest Plan, "Aspen" - pp 27-29; "Oak" – pp 39-40), forest openings, and understory forage production. Treatments can mimic the structure and patterns of reference conditions, and progress toward desired conditions and objectives. Thus, reconstructed reference conditions are general guides rather than rigid restoration prescriptions.

The Forest Plan (USDA FS 2014) briefly discusses the existing and desired conditions of the ponderosa pine forest as follows:

"Ponderosa pine forests on the Kaibab NF are generally denser and more continuous across all developmental states than in reference conditions. The open, park-like stands characteristic of the reference conditions for ponderosa pine forests promoted greater floral and faunal diversity and fire resilience than the dense stands of today. Accumulations of forest litter and woody debris are much higher than would have occurred under the historical disturbance regime. Lack of fire disturbance has led to increased tree density and fuel loads that heighten the risk of uncharacteristically intense wildfire and drought-related mortality. When fires occur under current (2014) conditions, they tend to kill a lot of trees, including the large and old trees. These trees take longer to replace, moving the Kaibab NF further from desired conditions, and increasing the time it would take to return to desired conditions. There is currently a moderate risk of insect and/or disease outbreak, which is also a function of increased tree density." *(Forest Plan, pg. 16)*

Existing Condition and Purpose and Need

The comprehensive purpose of the Burnt Corral vegetation management project is to improve ecosystem resilience and function at the landscape level, and to sustain healthy forests and watersheds for future generations.

To move the Burnt Corral project area toward Desired Conditions written in the Forest Plan (Kaibab NF, Forest Service, 2014), we plan to accomplish the following objectives:

- Improve forest health and vigor to maintain ecosystem resilience to natural disturbance, notably stand replacing, crown fires; outbreaks of tree killing bark beetles; and widespread disease infestations.

- Restore ponderosa pine resistance to historic and natural condition more resilient to major disturbance events.

- Meet Forest Plan objectives at the mid-scale level for basal area ranges conducive to forest health, generally 60 – 80 square feet per acre.

- Promote and maintain a ponderosa pine/frequent low-intensity fire regime community with a diversity of composition, size, and age structures in trees, grasses, forbs, and shrubs.

- Maintain ecosystem services such as watershed protection and wildlife habitat by improving tree vigor and resistance to insects and disease; keep populations at endemic levels.

See Figure 1 for an example of mortality in BC from the western pine beetle, *D. brevicomis.* Current populations of this bark beetle are endemic; conditions exist for an increase in activity and potential mortality.

Figure 1 Group of large ponderosa pine trees killed by the western pine beetle.

Western pine beetle populations often increase considerably during periods of drought, and over-stocked stands are subject to western pine beetle attack. These beetles kill host trees from 6" dbh pole-sized ponderosa pines to yellow pine with diameters over 36". Populations of western pine beetles can increase when large numbers of susceptible hosts are present, and the large number of beetles can spread to other stands with generally low susceptibility. These outbreaks can last for several years and can affect forests over widespread areas (Forest Health Protection Staff, Rocky Mountain Research Station, 2011).

Management recommendations to improve the health and vigor of residual ponderosa pine trees to resist attack include reducing basal area to 55 - 70 % of full site utilization to relieve competitive stress (DeMars and Roettgering, 1982).

There is a need to:

- Reduce forest fuel loads and tree densities to fire resistant condition;
- Reduce ladder fuels and increase tree crown base heights;
- Create openings in the forest canopy that helps drop fire to the surface;
- Reduce tree density and basal area to the lower range of site occupancy, about 35 – 40% of max SDI (Stand Density Index);
- Protect old growth patches on the landscape with thin from below treatments to improve resistance to catastrophic, stand-replacing crown fires;
- Improve ecosystem resilience in critical goshawk nest areas with thin from below and ladder fuel reduction treatments; and
- Increase the presence of aspen in the ponderosa pine type with group patch cuts near and adjacent to aspen, and removing ponderosa pine trees from within aspen clones.

"Aspen stands generally occur on moister sites and tend to have higher biodiversity and a greater abundance of plants, fungi, invertebrates, mammals, and cavity-nesting bird species than the surrounding forest. Aspen is second only to riparian ecosystems in biological diversity on the Kaibab NF, and supports more bird species than other forested areas. Even small aspen stands provide refugia. The soft wood of decaying stems and snags provide valuable habitat, particularly for cavity-dependent species." *(Forest Plan, pg. 27)*

Figure 2 Small aspen clone in project area with potential for expansion.

There is a need for prescribed burning and burn block preparation using manual and mechanical thinning (hand tools, chainsaws, a rubber-tracked skid steer with a mastication head) along control lines. Some piling of activity fuels would occur as well.

Control lines would be developed using existing roads within the proposed project area. Prescribed burning objectives would be to reduce Fire Regime Condition Class (FRCC) from 3 to 2, improve wildlife habitat, and enhance forest health.

Even though this project has a fire and timber emphasis, the district would follow the KNF Forest Plan, and protect wildlife habitat in all vegetation types, especially goshawk habitat in ponderosa pine, and Mexican Spotted Owl habitat in mixed conifer.

There was a managed wildfire in ponderosa pine in the south and central area of BC on about 3,900 acres that occurred during the summer of 2015. The Burnt Complex was primarily a surface fire that removed duff, and litter and reduced the density of small trees as it moved across the forest floor. Follow-up plots and reconnaissance were accomplished in 2016. All the data and results are part of the project record.

We installed plots to determine the presence or absence of bark beetles after the fire. Red turpentine beetle (RTB), *Dendroctonus valens*, is one of the first colonizers of the lower bole and larger, exposed roots of stressed, injured, dying and recently dead ponderosa pine trees. Attack by the RTB may not cause mortality as compared to more aggressive bark beetles, especially *D. brevicomis or D. ponderosae,* yet in combination with other insect and disease vectors is an important indicator of tree health (Owen et al, 2010).

Another agent of concern would be the pine engraver, *Ips pini.* This bark beetle is associated with disturbance, especially windthrow, drought, and fire. Weakened and stressed trees provide ideal conditions for population buildup, and potential tree attack (Kegley et al, 2015).

Also, true fir was assessed in the Burnt Complex for the fir engraver bark beetle, *Scolytus ventralis.*

The ponderosa pine type comprises over 21,000 acres in the project area and ranges from small openings created in the mid-1990's (Burnt Saddle group selection patch cuts), to even-aged advanced regeneration from the Pine Hollow timber sale to old growth blocks designated during the early 1990's. The southeast portion of BC contains about 360 acres of MSO recovery plan habitat with a mix of ponderosa pine, white fir, Douglas-fir, aspen, and blue spruce.

The Westlake Tanks are riparian areas in the north and central part of BC that will be protected with old growth designations and treatments to improve forest health and fire resistance.

Throughout the ponderosa pine type are about 2,590 acres of protected goshawk nest areas that are currently very high in tree density and basal area. There is a need to improve forest health and fire protection so we can maintain this valuable wildlife habitat.

Proposed Action

Personnel from the NKRD propose to use commercial tree thinning, group selection regeneration patch cuts, timber stand improvement (TSI) thinning, and prescribed fire in Burnt Corral. There would be over 27,000 acres of controlled fire, and up to 17,400 acres of commercial treatments. Inside these commercial thinning blocks, we plan to create about 900 acres of openings with small group selections. These would be from .5 – 3 acres in size, and the best seed trees would be left to naturally regenerate the openings. Depending on availability, we would leave about 5 of the best seed trees per acre on site when the patch cut exceeds two acres.

The placement of these group selection patch cuts would also promote greater diversity of stand composition with aspen and oak regeneration, especially near and adjacent to these clones. Also, by removing ponderosa pine trees within the aspen and oak clones, we would potentially increase the presence of these two species.

Furthermore, we plan to thin from below on about 2,590 acres of goshawk nest areas, and about 2,180 acres of old growth.

These proposed actions would emulate natural disturbance on the landscape to mimic nature and to promote fire resistance and ecosystem resilience. A major threat to the ponderosa pine forest in Burnt Corral is a host of tree-killing bark beetles, notably *Dendroctonus brevicomis,* (western pine beetle), *D. ponderosae,* (mountain pine beetle), and *D. adjunctus,* (roundheaded beetle). When basal area and average tree diameters contribute to high SDI, above 56% max in the range of competition-induced mortality, the potential for bark beetle outbreaks exists. Our task in BC is to prevent such outbreaks and retain ecosystem services across the area. See below for excerpts from Dr. James Long's paper on emulating natural disturbance in response to the scoping document for BC:

Many changes in perspectives in forestry are making their way into the balance of choices that are before us. A recent read of an article by James N. Long of Utah State University titled "Emulating natural disturbance regimes as a basis for forest management: A North American view." (Kane County Board of Commissioners, 2015)

Long references "refocusing of efforts from production forestry towards forestry in the service to a broader set of resource values". His statement points to a means of enjoying both the utility of our forests and conserving them and informing a broader public at the same time. "This refocus of emulating a natural disturbance regime (ENDR) is emerging as a dominant paradigm in North American forest management." Long goes on to state "ENDR represents management strategies and practices, at appropriate spatial and temporal scales, with the goal of producing forest ecosystems ... structurally and functionally similar ...to the ecosystems that would result from natural disturbances (Long, 2009)."

Past logging methods on the NKRD were typically individual tree selection known in the vernacular as "pick and pluck". This harvest system **emulated** the natural removal of trees from insect and disease attacks, blowdown, lightning strikes, or related calamities. This tree harvest process produced low volume per acre, and enabled the FS and loggers to treat large areas in a relatively short period of time. The loggers referred to the method as "capturing mortality" and "getting across the mountain" to remove those trees infected or susceptible to insect and/or disease agents (Personal experience and conversations with Kaibab Forest Products loggers, 1987 – 1996).

Group selection methods emulate small patches of trees killed by wind events, or bark beetles, and the subsequent natural regeneration of ponderosa pine in these openings.

Following initial commercial thinning, group patch cuts, and timber stand improvement, BC would be maintained with controlled fire treatments. Implementation of burning and mechanical thinning activities would begin after implementation of the proposed actions, and would continue until completed.

Timber stand improvement and small tree thinning would occur after commercial thinning treatments on about 16,500 acres. This involves cutting trees from about 2' in height to 8.9" DBH to remove excess trees from the stand to desired levels of ~125 trees per acre less than 9" dbh. See Table 1.

Table 1. This is a summary of mechanical treatments and acres in the Burnt Corral project area.

TYPE	TREATMENT	ACRES	SEQUENCE
Goshawk nest areas	Thin from below to 14" dbh	~2,590	Before RX burning actions
Old Growth areas*	Thin from below to 16" dbh	~2,180	Before RX burning actions
MSO habitat	Thin from below to 12" dbh	~360	Before RX burning actions
Burnt Saddle group strata	Thin thru size classes to 80 BA	~4,215	Concurrent with RX burns
Patch cuts in PP strata**	Create 1 – 3 acre openings	~900	Concurrent with RX burns
Group Select Matrix	Thin thru size classes to 80 BA and create 1 – 3 acre patch cuts	~8,420	Concurrent with RX burns
Timber Stand Impvmnt.	Thin from 2' to 8.9" dbh	~15,430	After commercial thinning

*** Some old growth acres are in Nest Areas, and we plan to cut to 14" dbh in the overlap areas.**
**** The 900 acres of patch cuts are contained and within the 8,430 acres in the Group Select Matrix**

The analysis for the Burnt Corral vegetation report implements the most current FVS models and the Stand Density Index literature taught in the Regional Advanced Silviculture training sessions for the Forest Service.

Analysis

Forest Vegetation Simulation (FVS)

FVS is used for predicting forest stand dynamics and is used extensively in the United States. This standard model is used by various government agencies including the USDA Forest Service (Dixon 2008). The Central Rockies variant of the model was used for the Burnt Corral geographic area.

The BC project area is well-represented with stand exam data that was used in the modeling process. The data collected for the project was as recent as 2010, yet some of the stand data is 15 years or older. FVS is a tree growth model with the capability to update stand conditions to the present. FVS was used to create silvicultural treatments in 2018, and growth 45 years following treatment. The results of various model scenarios are included in the report as average summary tables, compute tables, and compilations of the data.

FVS is a very good tool, but there is one major limitation to the model. FVS is density dependent which limits the ability to model openings created for uneven-aged management using group selection. FVS is not a spatial model.

Stand Density Index (SDI)

Reineke's Stand Density Index (SDI) uses quadratic mean diameter (Dq), and trees per acre (TPA). This index is presented as a ratio (%SDI) of the observed SDI to the maximum SDI for the species (Jack and Long 1996). SDI was developed for even-aged stands to describe the relationship between quadratic mean diameters and stem density. See the following figure that depicts the five stages of stand development.

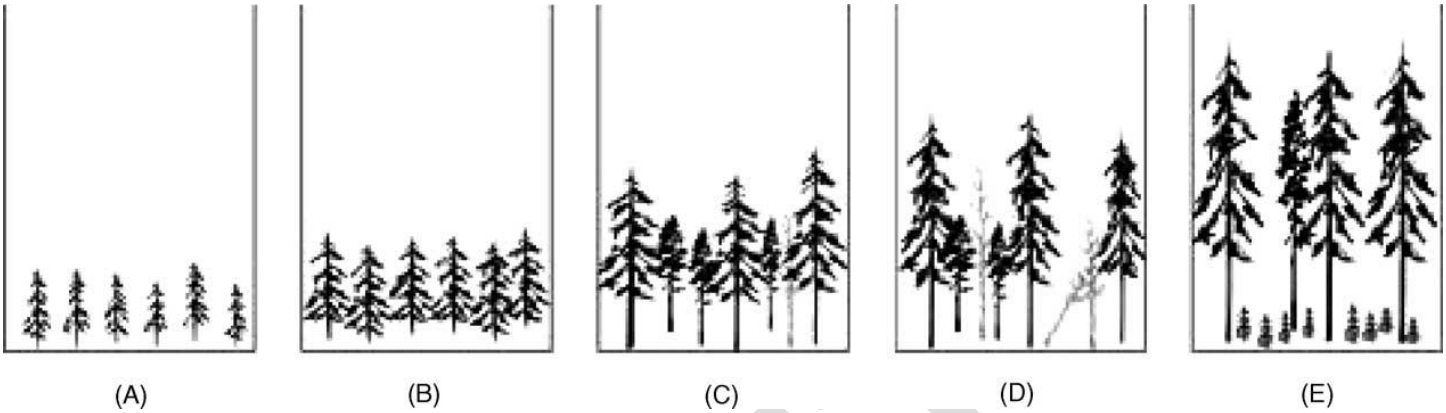
Full site occupancy (C) for ponderosa pine in the southwest is between 35% – 55% max SDI (RMRS Silviculture lecture series 2009).

Maximum SDI for southwestern ponderosa pine is 450 (FVS model).

Table 2. Relationship of percent of maximum SDI and Langsaeter's zones to stand and tree characteristics (Long et al 2004). (Forest density relative to stand and tree characteristics).

% Maximum SDI*	Zone	Stand and Tree Characteristics
0 – 24% (SDI >108) Low density	1	Less than full site occupancy, maximum understory forage production. No competition between trees, little crown differentiation. Maximum individual tree diameter and volume growth. Minimum whole stand volume growth. <u>For mixed-conifer forest types</u>: Regeneration of shade intolerant tree species favored (early seral species - Ponderosa pine, aspen**)
25-34% (SDI = 109-153) Moderate density	2	Less than full site occupancy, intermediate forage production. Onset of competition among trees, onset of crown differentiation. Intermediate individual tree diameter and volume growth. Intermediate whole stand volume growth. <u>For mixed-conifer forest types</u>: Regeneration of shade intolerant tree species favored (Ponderosa pine, aspen). Conditions becoming suitable for more shade tolerant species (early-mid seral species- Douglas fir, white pine**)
35-55% (SDI = 154-248) High density	3	Full site occupancy, minimum forage production. Active competition among trees, active crown differentiation. Declining individual tree diameter and volume growth. Maximum whole stand volume growth. **Upper range of zone marks the threshold for the onset of density-related mortality**. <u>For mixed-conifer forest types</u>: Regeneration of shade tolerant tree species favored (mid-late seral species - true firs, spruce species**)
56%+ (SDI = 249+) Extremely high density	4	Full site occupancy, minimum forage production. Severe competition among trees, **active competition-induced mortality**. Minimum individual tree diameter and volume growth, stagnation. Declining whole stand volume growth due to mortality. <u>For mixed-conifer forest types</u>: Shade tolerant tree species favored (late seral species - true firs, spruce species **)

SDI is depicted graphically below to illustrate the important stages of stand development and as a critical metric for analyzing forest health and vigor.



Stages of stand development for an idealized even-aged stand. (A) Trees are free-to-grow; (B) onset of competitive interaction; (C) full site occupancy; (D) self-thinning; (E) stem reinitiation (Long and Smith, 1984).

Best Available Science

The best available science is a composite of several key elements. The elements of science used are:

- **On-site data and history**. The project area was surveyed and Common Stand Exam data was collected.
- **Scientific literature**. Literature reviewed and cited is listed in the appendix.
- **Modeling using currently acceptable analysis**. The vegetation resource was analyzed using the current Forest Vegetation Simulation model. The model uses Stand Visualization Systems, and stand summary statistics to predict future stand structure, density, and composition.
- **Professional knowledge, judgment and experience**. The primary specialist who conducted the Vegetation resource analysis was Garry Domis. The analysis would be reviewed by resource peers. The collective professional knowledge of the project area, judgment of how to integrate science with local conditions, and the experience gained from implementation of other projects have been incorporated into the analysis. Andrew Orleman, Certified Silviculturist, conducted field reconnaissance and also contributed to the Vegetation Resource analysis.

I) AFFECTED ENVIRONMENT

Burnt Corral is an area dominated by ponderosa pine in the central and western portion of the NKRD. The terrain is dominated by the Kaibab plateau yet drops off the top into canyons on the west and southwest part of the area. The Bridger burn from 1996 dominates the western edge of BC.

This report describes the vegetation in the Burnt Corral project area. The descriptions are related to criteria determined to be part of a properly functioning ecosystem (Amundson et al. 1996). A Properly Functioning Ecosystem (PFC) is based on terminology developed in Region 4, and a PFC is considered to be resilient to disturbances in structure, composition, and biological or physical processes. Systems at risk are those that may

be degraded beyond the range of resiliency and sustainability. Similarly, in the Southwestern Region, the central priority is to restore the ecological functionality of forests and grasslands, especially the restoration of fire-adapted ecosystems. Both Properly Functioning Condition, and the restoration of fire-adapted ecosystems, relate to the ability of the system to withstand periodic, natural disturbances such as fire, insect attacks, disease, and natural calamity.

Burnt Corral is in the Burnt Corral and Big Saddle geographic areas.

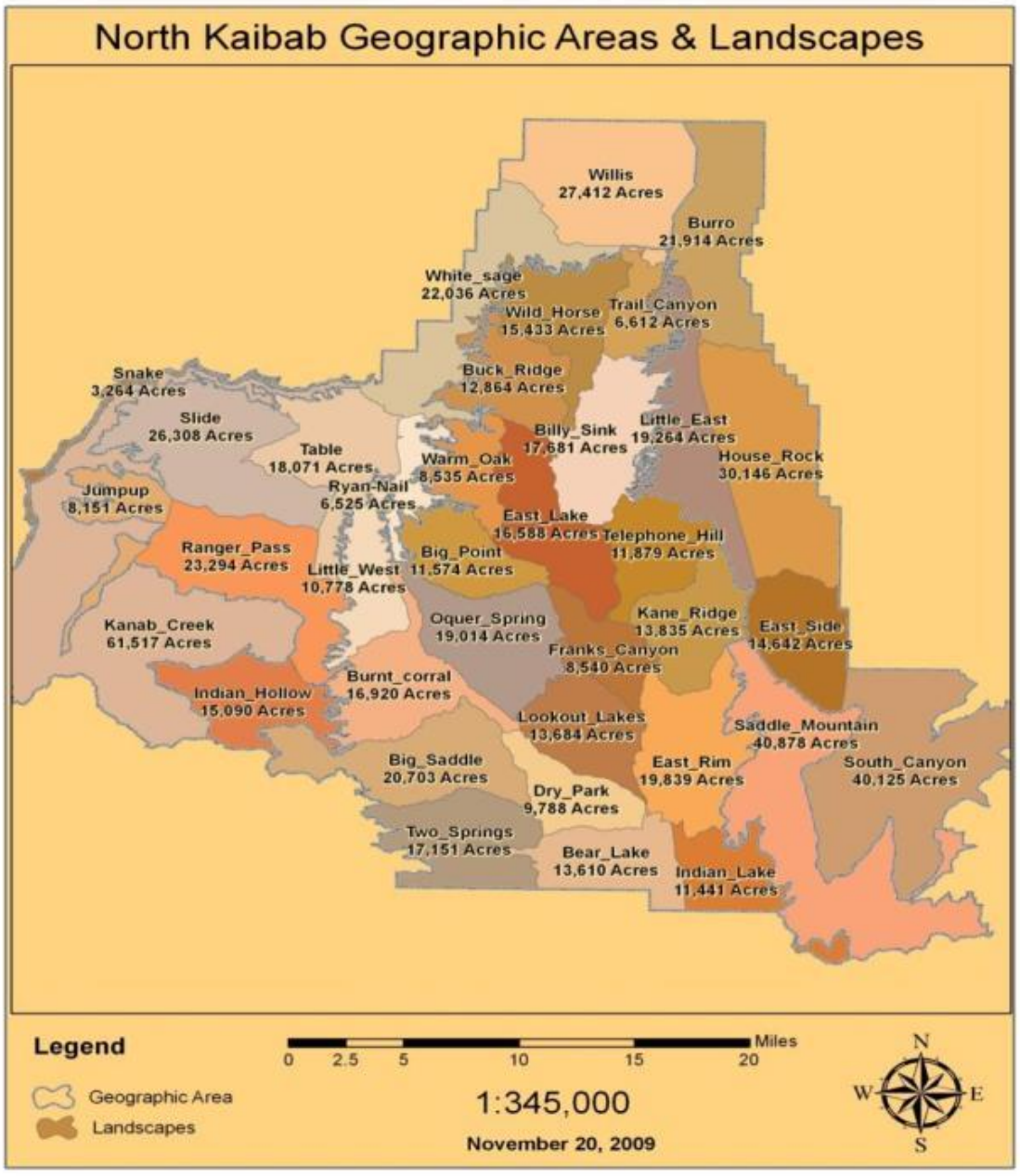


Figure 3 North Kaibab RD geographic areas

Vegetative Structure

Structure is the presence, size, and physical arrangement of vegetation in a stand. Vertical structure represents a variety of plant heights, from the forest floor to the canopy. Horizontal structure is the type, size, and distribution of trees and other plants across the surface from the forest floor to the canopy. In a forested environment, vegetation structure also includes snags (dead, standing trees), downed logs and woody debris, old trees, and crown connectivity (Reynolds et al, 2013; KNF Plan, 2014). Stand structure is immediately evident to the observer, and multi-storied and uneven-aged stands represent the desired condition for Burnt Corral.

Figure 4 Uneven-aged stand with larger trees in foreground and younger forest in the back.

Past management practices and disturbance regimes have had the greatest influence on structure. The two major changes in southwestern ponderosa pine forests, a major component of Burnt Corral, have been the simplification of structure, and increased density (Long and Smith 2000). The ponderosa pine type in Burnt Corral dominates the forested area in the project.

The maintenance and vigor of resilient ponderosa pine and aspen in Figure 5 represent desired conditions because the thick-barked conifer trees are resistant to fire, and the absence of dead limbs raises the canopy base height. Aspen is advantageous for fire resistance, and is able to sprout and maintain tree cover. The openings created from thinning and prescribed fire represent areas where surface fire would be more natural and historic.

Figure 5 Desired composition of ponderosa pine and aspen for species diversity and fire resilience.

Current Condition

The ponderosa pine component in Burnt Corral is characterized by two different stages in stand development and relative density. Currently, about 40% of the ponderosa pine stands are characterized by high basal area. The average total BA is ~170 with ponderosa pine making up over 80% of the stocking.

Depending on site and regeneration needs in ponderosa pine, the Plan recommends a range of basal area from 20 to 80 sq. ft. /ac. Group selection patch cuts (regeneration treatments) with seed tree retention would be in the 20 sq. ft. range with an open, park-like condition simulating historic stands (Reynolds et al, 2013). The added benefit of opening the canopy with strategic placement of patch cuts would be fire resistance and protection.

At the higher range of basal area, promotion and maintenance of uneven-aged forest is desirable. Uneven-aged forest with at least three stories or canopy layers is desirable for a host of ecosystem services including wildlife habitat, forest structure, and diversity. The current stand averages are very high compared to desired levels and would necessitate commercial thinning and tree removal to move the area to a healthier and more vigorous ecosystem.

Table 3. Summary statistics for ponderosa pine in Burnt Corral outside old growth and nest areas. (BA = basal area; TPA = trees per acre; SDI18 = stand density index of trees > 18" dbh; TPAPP18 = tpa > 18" dbh).

YEAR	TPAPP18	TPAALL	TPAPP	BAPP	BAALL	BAGT18	SDI18	SDIPP
2014	28.82	1045.63	224.53	133.53	163.61	94.50	172.62	261.59
2018	29.47	1011.32	219.59	136.45	168.51	97.26	175.83	264.63
2024	30.27	964.71	211.67	140.14	175.54	101.09	180.19	267.85

Average basal area for all species is ~169 sq. ft. per acre with ponderosa pine comprising about 80% of the stocking. The average SDI for ponderosa pine is 265 which has resulted in competition-induced mortality. A desired range of site occupancy would be at the lower end, or about 35% of max SDI, and these stands are currently over 59%. When basal area in ponderosa pine exceeds 150 sq. ft. per acre in densely stocked stands, it is susceptible to mountain pine beetle (Gibson et al, 2009).

The current stands analyzed have a large proportion of trees greater than 18" dbh, about 29 per acre, and these trees comprise 97 sq. ft. of basal area per acre, or 71% of the ponderosa pine stocking. Though overall trees per acre is very high, over 1000 TPA, the majority are in small ponderosa pine, aspen, Gambel oak, and others. Many of these excess trees would be removed with small tree thinning, and controlled, surface fire.

Based on existing high basal area and SDI levels in these stands, commercial harvest combined with thinning trees less than 9" dbh would be timely and would improve tree health and vigor in the BC ecosystem.

Old Growth and Goshawk Nest Stands

Burnt Corral contains stands classified as old growth and Northern Goshawk nest stands. These areas are characterized by high basal area, a large proportion of mature and overmature trees, dense canopy cover, standing snags, and downed logs and debris. Typically, these are uneven-aged stands with ideal habitat conditions for a host of animal species, and the capability to provide important ecosystem services including soil and watershed protection. These areas are very scenic and provide recreation opportunities and services as well. Old growth and goshawk nest areas represent about 4,770 acres in BC to be protected with thinning from below to improve forest vigor and reduce crown fire hazard. A combination of stand data, field reconnaissance, and GIS analysis determined the old growth areas. The nest stand layer was developed by the District biologist.

See the following metrics for the old growth stands modeled into the future. Basal area and SDI increase to hazardous levels for potential insect attack and for crown fire due to a predominance of large trees, heavy fuel loads, and mortality (MORTY = mortality in cubic feet, and MORTREE = snags as trees per acre). VOLUME is measured in cubic feet; LGTRZ = trees > 18" dbh; and FUELLDZ = fuel loads in tons per acre.

Table 4. Summary statistics for current and projected condition in old growth stands.

YEAR	LGTRZ	BAALL	SDIALL	CANCOVR	VOLUME	MORTY	MORTREE	FUELLDZ
2014	36.05	171.06	381.76	45.77	5789.65	11.36	1.94	14.09
2018	36.62	175.04	386.95	47.91	5902.08	15.28	2.20	15.84
2024	37.50	180.17	393.08	49.56	6043.78	15.74	2.60	17.31
2034	38.99	188.24	402.13	52.63	6238.33	17.14	3.28	19.26
2044	40.49	194.34	405.77	55.28	6355.64	22.41	4.15	21.81
2054	41.14	200.30	410.56	57.15	6498.68	19.95	4.44	24.50

The northern goshawk nest stands display similar characteristics of high basal area, SDI, and many large trees per acre. See the average summary table below. The sizeable amount of trees per acre includes many small pine,

aspen, and oak with mortality from dense tree stocking. Also remarkable is the predicted increase in mortality to 19 cubic feet per acre after 14 years.

In old growth stands, there is a high volume of standing inventory in trees greater than 5" dbh, over 5,900 cubic feet per acre projected for 2018. These conditions are not sustainable over time without controlled management like commercial timber harvest, small tree thinning, and surface controlled ground fire. Ecosystem sustainability is the capability of the forest to maintain services in space and time in perpetuity, especially the protection of soils, watersheds, habitat, and timber (Reynolds et al, 2013).

Table 5. Average summary metrics for current and projected condition in goshawk nest areas.

FVS SIMULATION: BCNestsNoAcFEB2015
SIMULATION DONE: 01-26-2016 06:41:30

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2010	16	1030	139	324	104	81	6.1	4472	4145	23817	0	0	0	0	139	324	104	81	6.1	8	41	11	0.0
2018	24	988	148	340	112	82	6.4	4717	4362	25146	0	0	0	0	148	340	112	82	6.4	2	40	18	0.0
2020	26	970	150	342	114	82	6.5	4760	4400	25360	0	0	0	0	150	342	114	82	6.5	10	40	14	0.0
2030	36	913	161	357	123	84	6.9	5017	4606	26635	0	0	0	0	161	357	123	84	6.9	10	41	19	0.0

It is very critical that we protect and maintain wildlife habitat and watershed protection in the Burnt Corral project area. The NKRD contains valuable assets required to be managed for multiple-use and the benefit of the Agency and the public. From experience and past management of this forest since establishment, we know the techniques and forest practices to keep a healthy and green forest. We should use proactive management and restoration of forest types to historical condition to mitigate uncontrolled wildfires displayed below from the Warm Fire on the NKRD in 2006.

Figure 6 Aftermath of the Warm Fire, 2006, showing a devastating stand replacing crown fire.

Ecosystem services are very important for maintaining and sustaining the multiple uses of the NKRD. This photograph of the Warm fire illustrates the loss of habitat, timber, soil, and recreational opportunities on the District. As land managers, we are tasked with averting this scenario in the future.

Forest Plan Implementation

Preventive management using commercial tree harvest, small tree thinning, and controlled surface fire would be important tools to implement the Forest Plan and avoid destructive crown fires as displayed above. The KNF plan has an ambitious goal of treating between 24,000 to 74,000 acres annually with mechanical and controlled fire treatments:

Objectives for Ponderosa Pine

To make progress toward the desired conditions and reduce the potential for active crown fire in ponderosa pine communities at a rate that would maintain the desired conditions over time:
• Mechanically thin 11,000 to 19,000 acres annually.
• Treat an average of 13,000 to 55,000 acres annually, using a combination of prescribed fire and naturally ignited wildfires. (Forest Plan, pg. 19).

The NKRD would then proportionally treat about 40% of those acres, or about 9,700 to 29,000 per year in ponderosa pine. This is why BC is so important to forest management on the District at the landscape scale. To restore and maintain the ponderosa pine forest on the NKRD, almost 200,000 acres, we would need almost 20 years to manage the ponderosa pine belt at the minimum treatment level described above. This cycle would

correspond to Fire Regime I in ponderosa pine with frequent, low-severity fires across the landscape with return intervals between 0 to 35 years (KNF Plan, pg. 18). Recently, the KNF has used prescribed fire and managed wildfires to achieve this yearly goal though mechanical treatments have so far lagged behind. The intent of Jacob-Ryan and BC on the NKRD, and Four Forests Restoration Initiative on the south side, is to mechanically treat at least 11,000 acres of ponderosa pine each year.

II) METHODOLOGY

Northern Goshawk Management and Mexican Spotted Owl

Regionally Consistent Standards and Guidelines
Standards and guidelines to be added to each forest plan for Mexican spotted owl habitat, northern goshawk habitat, grazing utilization, and old growth designation follow. Standards and guidelines are the bounds or constraints within which all management activities are to be carried out in achieving forest plan objectives (KNF Forest Plan 2014).

Mixed conifer forests are managed as Mexican spotted owl habitat under the approved "Mexican Spotted Owl Recovery Plan, First Revision" (USFWS 2012). The Kaibab NF works closely with the USFWS to provide for Mexican spotted owl habitat by minimizing disturbance, providing for some areas of denser forest, and managing for desired levels of key structural elements (e.g., large old trees and snags, downed woody debris) important for nesting, foraging, and dispersal (KNF Forest Plan 2014).

III) RANGE OF ALTERNATIVES AND MITIGATION MEASURES

Range of Alternatives for Analysis

Alternative 1—Proposed Action:
Personnel from the NKRD propose to use commercial tree harvest, timber stand improvement thinning, and prescribed fire in Burnt Corral. There would be over 27,000 acres of controlled fire, commercial harvest on about 16,500 acres, and small tree thinning on most of the harvest acres plus preparation of burn blocks as designated by fire personnel. Some thinning and burn block preparation might include mastication with a FECON head on heavy equipment.

Following the initial prescribed fires and mechanical thinning treatments, the Project Area would be maintained either through managed wildfires or periodic prescribed fire treatments. Implementation of burning and thinning activities would implement the proposed action, and would continue until completed.

Budget allocations and available resources would also impact the timing and accomplishment of targeted treatment areas. Treatment schedules would probably last more than five years from the start date.

Mitigation Measures

- Timing restrictions in the event a goshawk is active and fledging young birds. Harvest activities in the area would be curtailed from March 1st through September 30th, or until cleared by the wildlife biologist. This is common practice on the NKRD and is implementable and effective.

- Cut stumps to 6” or less in height for visual quality purposes; implementable and effective as a common practice on the NKRD in, near, and around recreation facilities.

- Allow firewood collection in slash piles to ensure prompt clean-up of slash at the landing areas. Implementable and effective due to the ease of access and transport of firewood for the purchaser.

- Use small tree thinning contracts to accomplish the mechanical treatments in Burnt Corral. This practice would be implementable and effective in the project area.

Alternative 2—No Action:
Current and existing management plans would continue to guide the project area. No mechanical vegetation management or prescribed burning would occur.

IV) EFFECTS ANALYSIS

1) Effects of not implementing the project actions (No Action).

Ponderosa Pine:

Throughout the modeling period, the basal area in BC, dominated by PP (ponderosa pine), would increase to non-sustainable levels. By 2066, the BA is over 200 sq. ft. per acre and the SDI is 423, or 85% of max. Max SDI is the weighted average of PP and aspen, about 500. Mortality from competition is very high at 30 cubic feet per acre, or 50% of growth. There will be disturbance in this stand and it would not reach these density levels because wildfire, insects, and disease will occur to reduce stocking. In arid Southwest forests, the question is when, not if, the disturbance will occur.

Table 6. FVS statistics for ponderosa pine stands in BC with no action.

FVS SIMULATION: BurCorlAllNANoSeCutFeb2016
SIMULATION DONE: 02-24-2016 16:16:54

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	QMD	RES PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2016	21	1127	156	363	127	78	6.3	4452	4050	22326	0	0	0	0	156	363	127	78	6.3	10	48	13	0.0
2026	31	1033	170	382	139	80	6.8	4806	4340	23933	0	0	0	0	170	382	139	80	6.8	10	49	17	0.0
2036	41	939	181	397	151	81	7.3	5128	4584	25216	0	0	0	0	181	397	151	81	7.3	10	52	19	0.0
2046	51	862	192	409	161	82	7.7	5458	4862	26361	0	0	0	0	192	409	161	82	7.7	10	54	23	0.0
2056	61	783	202	417	170	83	8.2	5773	5186	27200	0	0	0	0	202	417	170	83	8.2	10	58	26	0.0
2066	71	713	210	423	178	84	8.7	6090	5542	27869	0	0	0	0	210	423	178	84	8.7	10	60	30	0.0
2076	81	649	217	426	184	84	9.3	6389	5874	28430	0	0	0	0	217	426	184	84	9.3	0	0	0	0.0

The direct effects of dense tree stocking would be reduced light, moisture, and nutrients available to individual trees. Many stands contain over 1,000 trees per acre compared to desired levels of about 130 – 150 (Menasco, 2009). As trees vie for light, moisture, and nutrients, competition-induced mortality would occur over the entire modeling period. Mortality almost triples in fifty years. The direct effect of no action would be stagnant ponderosa pine stands at high risk for crown fire and bark beetle attack. Overstocked stands have intense competition for light, water, and nutrients which causes increased stress. Thinning alleviates this stress by reducing competition and making growth resources more available to remaining trees (Chase et al, 2016). Retained trees after prescribed thinning would have better genotypic and phenotypic qualities, especially straight boles, robust crowns, faster growth, and disease free.

Insect and disease conditions in the older trees would likely result in mortality from western pine beetle, roundheaded pine beetle, and dwarf-mistletoe. Group killing of trees by the western pine beetle is common in dense, overstocked stands of pure, even-aged ponderosa pine trees (Demars and Roettgering 1982). The roundheaded borer also works in conjunction with western pine beetle to attack stressed and weakened trees, and may kill up to 50% of trees in pure stands, both small and large diameter (Massey et al 1977). Trees weakened by moisture stress and bark beetles may also succumb to dwarf-mistletoe as foliage becomes thin, short and yellowish, and the top dies (Lightle and Weiss 1974). When average BA is 110 or greater, evident throughout the modeling period, there is a risk of infestation from tree-killing bark beetles (Amman et al 1989), including the mountain pine which is endemic on the NKRD.

Recent epidemics of some native forest insects have exceeded historical records. A variety of vegetation management practices could help prevent epidemics from occurring and expanding when strategically planned at landscape levels in a timely manner. Experience has shown that even a course of no action is not without consequence (Fettig et al 2007). The worst example of no action on the NKRD was the untreated areas of ponderosa pine and mixed conifer in the Warm Fire that were severely burned in 2006 with catastrophic consequences (Warm EIS 2009).

Changes in forest structure and composition by natural processes and management practices have led to increased competition among trees for water, nutrients and growing space with increasing susceptibility to bark beetles and other insects. As trees become stressed, their insect resistance mechanisms are compromised. Trees of low vigor are more susceptible to bark beetle attack (Fettig et al 2007).

The No Action scenario in the ponderosa pine component of the Burnt Corral project would eventually result in stands at high risk for wildfire, and susceptibility to insect and disease attack. With regular small-tree thinning and periodic, controlled burning, the trees per acre would be maintained in a healthy range. Remaining trees would have less competition for water, light, and nutrients. Vigorous trees would have the resources to withstand periodic drought, and assault from insects and disease.

In the No Action scenario, for example, a simulated wildfire in the old growth stands would have the following results. Fire-related metrics for three old growth stands are displayed below. A crown fire in 2018 effectively kills most of the large trees, and causes extreme mortality; there is an average of only three large trees left per acre when each stand had over forty trees per acre pre-fire. Growth loss, or mortality, averages over 650 cubic feet per acre. Wildfire in the old growth stands would be devastating to habitat, scenic value, and timber. Canopy cover drops to less than 5% in the stands. (LGTRZ = trees > 18" dbh; FLLENG = flame length; MORTREE = fire-killed trees; TI = torch index; FUELLDZ = tons per acre of fuels on forest floor).

Table 7. FVS statistics for three stands in the old growth strata; no action with modeled wildfire.

SIMULATION:BurCorlOGFireFeb2016
Source: BurCorlOGFireFeb2016.out 02-26-2016 10:12:17

Stand ID: 0307030030380022
Mgmt ID: NONE

YEAR	CANCOVR	LGTRZ	MORTREE	FUELLDZ	TI	FLLENG	BAMORT	MORTY
2010	43.55	23.85	2.92	10.17	8.90	10.85	79.95	
2014	45.64	23.93	35.56	13.72	6.73	11.98	87.24	6.00
2018	48.73	24.38	1550.89	4.76	12.03	6.15	54.64	7.00
2024	4.92	3.01	87.45	24.01	4.33	10.05	39.55	607.00
2034	16.93	3.52	34.54	37.03	10.10	9.57	61.31	1.00
2044	26.46	4.11	22.81	41.38	11.80	9.70	73.78	1.00
2054	36.41	4.55	19.68	44.35	15.57	8.69	76.51	3.00

2064	45.78	4.80	18.38	45.80	25.83	7.37	76.35	5.00

Stand ID: 0307030030380039
Mgmt ID: NONE

YEAR	CANCOVR	LGTRZ	MORTREE	FUELLDZ	TI	FLLENG	BAMORT	MORTY
2010	42.48	26.00	2.60	9.77	16.64	7.74	41.16	
2014	43.73	25.85	35.06	13.83	8.59	10.90	68.60	7.00
2018	44.80	26.39	1796.19	4.39	88.28	5.66	30.54	8.00
2024	4.46	3.59	61.97	25.91	43.41	10.27	21.16	765.00
2034	7.46	4.36	23.99	39.81	40.26	11.70	37.33	1.00
2044	11.56	5.80	14.66	42.76	24.49	10.68	40.44	1.00
2054	17.18	6.09	10.60	45.46	42.12	9.41	44.84	1.00
2064	23.78	6.21	8.92	46.66	56.65	8.86	50.41	1.00

Stand ID: 0307030030390004
Mgmt ID: NONE

YEAR	CANCOVR	LGTRZ	MORTREE	FUELLDZ	TI	FLLENG	BAMORT	MORTY
2010	44.49	25.45	2.55	4.37	11.06	11.36	88.81	
2014	47.28	29.01	21.99	8.48	13.21	10.40	82.31	3.00
2018	50.11	30.69	1333.09	2.23	42.71	5.66	38.86	4.00
2024	4.57	3.24	57.51	21.69	23.23	9.80	27.68	588.00
2034	17.57	3.70	36.57	35.47	40.73	8.95	45.58	1.00
2044	28.32	4.33	23.79	39.94	54.77	8.19	57.97	1.00
2054	41.20	4.52	18.88	43.97	66.96	7.53	68.75	3.00
2064	54.17	5.51	18.06	45.61	109.25	7.07	76.68	5.00

Though insect outbreaks are a potential threat in the Burnt Corral ponderosa pine component, the most imminent peril would be stand-replacing wildfire. Swetnam (2010) showed mean fire intervals (MFI) of about 6 years in ponderosa pine in the southwest, and Fule et al (2006) found average intervals of 5.5 years on the Kaibab plateau south of the NKRD. Hunter et al (2007) found similar results in n. Arizona with the shortest intervals <3 years in pine. Wildfire in the southwest is a frequent, regular disturbance that potentially could burn in the ponderosa pine project area six times or more during the modeling period.

There have been three large fires on the Kaibab Plateau since 1987 – Willis, Bridger Knoll – 1996, and the Warm Fire – 2006. All three were stand replacing crown fires with accumulated burned acres at ~96,000 (NKRD GIS layer, personal work and related experience on the NKRD since 1978). The Willis fire was about 2,080 acres, and when the smoke cleared the summer of 1987, that was considered a very large fire for the District.

Given past fire history on the NKRD, “the question is not if but when will the next large wildfire occur”? With the no action alternative, a simulated wildfire in the BC project area is defensible.

Figure 7 This photograph shows a crown fire in "dog-hair" ponderosa pine thickets,

Figure 7 is an example of an explosive wildfire in a "dog-hair" thicket of advanced regeneration. This fire is destructive because forest sustainability is dependent on stands of young, live trees. When established regeneration of 20 – 30 year old trees is wiped out by wildfire, the direct effects include conversion to grass/brush, soil erosion, and watershed loss. There is a need to reduce tree density in the Burnt Corral ponderosa pine area with controlled surface fire, not crown fire as displayed above.

Mixed Conifer (Mexican Spotted Owl Habitat):

The habitat for the MSO comprises about 360 acres in Burnt Corral, about 1.3% of the project area. Though this habitat is a minor amount of the acres, the maintenance and protection of this habitat is an essential aspect of the KNF Plan.

Mixed conifer forests are managed as Mexican spotted owl habitat under the approved "Mexican Spotted Owl Recovery Plan, First Revision" (USFWS 2012). The Kaibab NF works closely with the USFWS to provide for Mexican spotted owl habitat by minimizing disturbance, providing for some areas of denser forest, and managing for desired levels of key structural elements (e.g., large old trees and snags, downed woody debris) important for nesting, foraging, and dispersal (Forest Plan, pg. 24).

The No Action alternative would not protect or move the MSO habitat toward desired condition according to the plan. Though no action would result in these stands becoming dense forest with large old trees, snags and downed woody debris, the risk for hazardous crown fire would persist. See Table 8 for the timber and tree metrics for MSO with no action for the modeling period.

Table 8. FVS statistics for MSO habitat under the No Action alternative.

FVS SIMULATION: BCMsoEC2016
SIMULATION DONE: 03-24-2016 08:42:49

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
1995	0	1806	122	335	119	78	3.7	3437	3019	15107	0	0	0	0	122	335	119	78	3.7	9	95	11	0.0
2004	9	1708	152	396	153	81	4.2	4188	3660	18157	0	0	0	0	152	396	153	81	4.2	10	103	18	0.0
2014	19	1589	184	453	189	84	4.8	5050	4389	21645	0	0	0	0	184	453	189	84	4.8	4	110	20	0.0
2018	23	1545	198	477	205	85	5.0	5408	4686	23031	0	0	0	0	198	477	205	85	5.0	6	113	24	0.0
2024	29	1474	218	508	227	86	5.4	5940	5110	25246	0	0	0	0	218	508	227	86	5.4	10	113	41	0.0
2034	39	1294	239	532	250	89	6.1	6658	5696	28840	0	0	0	0	239	532	250	89	6.1	10	110	48	0.0
2044	49	1128	256	546	268	91	6.9	7284	6339	31840	0	0	0	0	256	546	268	91	6.9	10	111	53	0.0
2054	59	984	271	555	282	93	7.7	7871	6971	34489	0	0	0	0	271	555	282	93	7.7	10	108	59	0.0
2064	69	854	282	555	292	94	8.6	8359	7493	36666	0	0	0	0	282	555	292	94	8.6	10	106	62	0.0

The increase in mortality is striking and corresponds to a dramatic increase in basal area and SDI. Current density levels are very high; 198 sq. ft. of basal area per acre, and SDI = 477. Using 700 for SDI_{max}, the current reading is 68% of max increasing to 76% in 2034. Both metrics exceed the initiation of competition-induced mortality which is 56% (Long et al, 2004). Net growth (Accretion minus Mortality) drops from ~90 to 44 cubic feet per year in 2064.

These levels are not sustainable because mortality increases at a high rate. By 2034, these stands have lost an average of ~150 trees per acre, and growth loss doubles from 24 to 48 cubic feet per acre. The stage would be set for a destructive crown fire that would impair MSO habitat, and other wildlife and watershed services.

Fire return intervals in frequent-fire mixed conifer across the landscape would be 0 – 35 years (KNF Plan, pg. 23). The Bridger Fire occurred in 1996 in the western portion of the project area. In the southeast section of BC, there have been no fires for at least 35 years (GIS Fire History layer). Using the rationale that fire will occur in these stands, a wildfire for the MSO area was modeled in 2035 at the predicted 90th percentile range. The FVS compute table follows with the following measurements (TPA18UP = trees per acre over 18" dbh; BAALL = basal area for all species; COVALL = canopy cover; TI = torch index; CRBASHT = crown base height in feet; SNG14ALL = snags over 14" dbh; DOWNWD = downed woody debris in tons per acre).

Table 9. Results of a simulated wildfire in MSO habitat in 2035.

SIMULATION:BCMsoEC2016
Source: BCMsoEC2016.out 03-24-2016 09:38:41
** Stands were weighted by sampling weight (usually acres) in calculating the average values.

YEAR	TPA18UP	BAALL	COVALL	TI	CRBASHT	SNG14ALL	DOWNWD
1995	16.16	121.56	50.96	12.85	3.32	4.83	0.00
2004	19.87	151.90	62.67	10.77	4.08	2.69	0.59
2014	23.06	183.80	69.59	3.15	2.60	2.53	0.96
2018	24.36	197.47	71.97	1.18	2.87	2.50	1.17
2024	26.34	216.70	74.38	3.20	3.60	2.58	1.45
2034	31.52	238.59	75.19	15.75	2.05	51.38	1.17
2044	4.80	17.67	6.90	7.22	2.16	28.02	10.79
2054	4.95	24.78	20.96	10.11	2.28	15.62	15.79
2064	5.50	31.06	27.19	11.50	2.40	8.75	18.00

The results in MSO habitat are devastating. The wildfire kills most of the large trees leaving only 5 per acre. Dense canopy would be reduced from 75% to 7%, and basal area drops to about 7% compared to pre-fire levels. The torch index was very low before the fire, needing only a 16 mph wind to move fire from the surface into the tree crowns.

Table 9. FVS average summary table of MSO stands after a wildfire in 2035.

FVS SIMULATION: BCMsoEC2016

SIMULATION DONE: 03-24-2016 09:38:54

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
		NO OF				DOM		TOTAL	MERCH	MERCH	NO OF	TOTAL	MERCH	MERCH				DOM	RES	PERIOD	ACCRE	MORT	MAI MERCH
YEAR	AGE	TREES	BA	SDI	CCF	HT	QMD	CU FT	CU FT	BD FT	TREES	CU FT	CU FT	BD FT	BA	SDI	CCF	HT	QMD	YEARS	PER	YEAR	CU FT
1995	0	1806	122	335	119	78	3.7	3437	3019	15107	0	0	0	0	122	335	119	78	3.7	9	95	11	0.0
2004	9	1708	152	396	153	81	4.2	4188	3660	18157	0	0	0	0	152	396	153	81	4.2	10	103	18	0.0
2014	19	1589	184	453	189	84	4.8	5050	4389	21645	0	0	0	0	184	453	189	84	4.8	4	110	20	0.0
2018	23	1545	198	477	205	85	5.0	5408	4686	23031	0	0	0	0	198	477	205	85	5.0	6	113	24	0.0
2024	29	1474	218	508	227	86	5.4	5940	5110	25246	0	0	0	0	218	508	227	86	5.4	10	113	41	0.0
2034	39	1294	239	532	250	89	6.1	6658	5696	28840	0	0	0	0	239	532	250	89	6.1	10	6	613	0.0
2044	49	221	18	37	15	16	1.4	591	550	3050	0	0	0	0	18	37	15	16	1.4	10	12	0	0.0
2054	59	218	25	54	23	26	2.9	706	622	3394	0	0	0	0	25	54	23	26	2.9	10	14	1	0.0
2064	69	213	31	67	30	33	3.7	833	679	3660	0	0	0	0	31	67	30	33	3.7	10	20	2	0.0

The no action alternative would not move the MSO habitat areas toward desired conditions. The current stocking levels of basal area, trees per acre, and SDI would not be sustainable into the future. When disturbance occurs, such as wildfire, the consequences would be loss of habitat and other important ecosystem services like watershed protection, recreational opportunities, and soil stabilization. By 2044, the loss of the growth potential for this area is salient. At 6 cubic feet per acre, growth has been reduced to 5% of pre-fire production levels (ACCRE = accretion or growth in cubic feet per acre).

Healthy, green forests produce many ecosystem services, especially the storage of atmospheric carbon (USFS, 2015; Malmsheimer et al, 2011).

"Managing America's forests and grasslands to adapt to changing climates will help ensure that they continue to produce the benefits that Americans need, while helping to mitigate the effects of a changing climate and to compensate for fossil fuel emissions through carbon storage in healthy forests." (USDA, Office of the Chief, 2015)

2) Direct and Indirect Effects of the Proposed Action

PONDEROSA PINE:

The Proposed Action in BC is a combination of treatments in strata developed by the collaborative. The group identified the following distinct areas for mechanical thinning treatments:

- Northern goshawk nest areas;

- Old growth stands;
- Burnt Saddle forest matrix;
- Patch cut areas in the Burnt Saddle timber sale;
- Mexican spotted owl habitat;
- Planned BC patch cuts for creating canopy gaps and openings for regeneration;
- Remaining matrix forest for thinning through a diameter range to target basal areas.

Northern Goshawk Nest Areas

The goshawk nest areas comprise about 2,590 acres across the project area. Commercial thinning from below would be planned to remove trees less than 14" dbh to reduce stocking, improve forest health, remove ladder fuels, and protect habitat.

See Table 10 for direct effects of the treatment. **Note well**: the sprouting function for oak and aspen was turned off in the **Planting and Natural Regeneration** feature. That is why the overall trees per acre by size reduce to manageable numbers. Since we would not physically cut aspen and oak, logging and controlled, surface fire would stimulate sprouting so the actual trees per acre would be well over the numbers displayed below, usually over 900 per acre shown in 2018. (TPAG14 = trees per acre > 14"; BALT14 = basal area < 14"; MORTREE = snags; TI = torch index; and CRBHT = crown base height).

From a Fire/Fuels perspective, the thinning treatment immediately reduced ladder fuels around remaining trees; the torch index is 94 mph in 2020, and crown base height lifted to 38 feet. Fire hazard would be considerably moderated with this action. Torch index measures the sustained wind in miles per hour for a surface fire to transition into the crown and ignite the canopy foliage. The crown base height is the average in the stand in feet from the forest floor to the first limbs and branches off the main trunk.

Table 10. Computed values for goshawk nest areas after thinning from below to 14" dbh.

```
SIMULATION:BCNestAreaTFB14inFEB2015
Source: BCNestAreaTFB14inFEB2015.out  03-01-2016  11:04:05
** Stands were weighted by sampling weight (usually acres) in calculating the average
values.
```

YEAR	TPAL14	TPAG14	BALT14	BAGT14	MORTREE	TI	CRBHT
2010	988.30	40.94	33.95	104.59	1.93	32.10	17.95
2018	945.55	42.30	37.53	110.27	2.28	131.08	37.63
2020	78.65	42.63	5.66	111.94	2.23	93.67	37.81
2030	75.81	42.16	6.47	117.55	2.27	66.99	38.67
2040	72.96	41.52	7.59	121.73	2.42	67.95	38.83
2050	70.05	40.75	8.66	124.69	2.75	69.73	38.81

The direct effects of thinning from below to 14" dbh in 2018 would be a reduction in trees per acre, and basal area. For example, in 2020, trees < 14" dbh would be 79 per acre with about 6 sq. ft. of basal area per acre. With fewer trees competing for available light, moisture, and nutrients, the residual trees would increase in growth and vigor with mortality decreased from 11 cu. ft. per year to 7.

Below, overall stand basal area drops from 148 to 118, and SDI by 2020 is within full site occupancy range at 192, or 38% of max. There would also be about 1,230 board feet per acre removed as saw logs. Another dramatic growth improvement would be doubling the average tree diameter from 6.4" to 13.1". This results from greater individual tree growth, and removing inter-tree competition.

Table 11. The FVS average summary table for goshawk nest areas after thinning from below to 14" dbh.

FVS SIMULATION: BCNestAreaTFB14inFEB2015
SIMULATION DONE: 03-01-2016 11:06:16

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2010	16	1030	139	324	104	81	6.1	4472	4145	23817	0	0	0	0	139	324	104	81	6.1	8	41	11	0.0
2018	24	988	148	340	112	82	6.4	4717	4362	25146	866	486	397	1227	116	190	80	80	13.0	2	34	7	0.0
2020	26	121	118	192	81	80	13.1	4286	4017	24262	0	0	0	0	118	192	81	80	13.1	10	32	8	0.0
2030	36	118	124	199	85	81	13.7	4526	4242	25807	0	0	0	0	124	199	85	81	13.7	10	30	10	0.0
2040	46	115	129	205	89	82	14.2	4724	4420	27038	0	0	0	0	129	205	89	82	14.2	10	28	12	0.0
2050	56	111	134	209	91	83	14.7	4879	4570	27959	0	0	0	0	134	209	91	83	14.7	10	26	14	0.0
2060	66	107	137	211	94	83	15.2	5001	4686	28616	0	0	0	0	137	211	94	83	15.2	0	0		

These direct, beneficial effects would be attributable to more growing space for the residual trees, and less competition for available sunlight, water, and nutrients.

The indirect effects of improved forest health, greater tree vigor, and less competition would be a fire-resilient ecosystem better equipped to ward off insects, disease, wildfire, and other calamities. The reduction in SDI from 68% to 38% of max would be an impressive result from this light commercial harvest.

Collaboration and implementation of the new KNF Plan could promote a major advantage over the 1986 KNF Plan, especially in valuable nest areas. The prior hands-off approach with no commercial logging or skidding equipment in these stands has resulted in dense, stagnant zones very susceptible to crown fire. The picture below is of a dense stand in ponderosa pine that would benefit from thinning up to 14" dbh.

Figure 8 Dense stand of ponderosa pine in need of understory thinning.

Old Growth Areas

Old growth forest structure includes accumulations of large, dead and fallen trees, and decadence in the form of broken or deformed tops, and diseases (Hamilton 1993). Old forest conditions develop over time, and can be managed to promote old growth. However, in southwestern ponderosa pine forests, disturbance regimes, especially fire, can keep forests in early to mid-seral stages, and delay the onset of "old forest" features.

In the arid Southwest, important historical features of ponderosa pine forests were high-frequency or low severity fires, and varied patterns of tree establishment. The result included small groups of relatively even-aged trees in multiple associates (Kaufmann et al 2007). These groups could also be described as patches and clusters, rather than stands.

See the following excerpt from the Kaibab Forest Plan:

• Old growth occurs throughout the landscape, generally in small areas as individual old growth components, or as clumps of old growth. Old growth components include old trees, snags, coarse woody debris, and structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). (Forest Plan, pg. 18)

Old growth forests or "landscapes contain sufficient numbers of patches and stands of old growth to be reasonably representative of the forest type in historical times". These landscapes can be in various stages of development, including temporary openings or patches of very young trees, which provide future old-growth

patches in the landscape (Kaufman et al 2007). Old growth descriptions and definitions are complex in the fire-adapted ecosystems of the Southwest compared to the lush, old growth rainforests of the Pacific Northwest. Frequent surface fires allowed for regeneration in patchy openings when the time and place of these openings coincided with reduced fire frequency and enough moisture for seed production, germination, and seedling survival. Historically, there would have been a shifting mosaic of old forest conditions in uneven aged groups and clusters.

The BC collaborative decided that old growth would benefit from thinning from below to 16" dbh. This choice departed from the previous KNF plan (1986) which had a "hands-off" approach in old growth with no heavy equipment or logging allowed. There are about 2,180 acres of old growth in BC for thinning from below treatments. There is an overlap of about 550 acres of old growth in goshawk nest areas that we plan to thin from below to 14" dbh. The old growth acres in BC are about 2,730 acres total.

The preservation style philosophies in critical wildlife habitat areas left stands susceptible to crown fire that destroyed PACs (protected activity centers), nest areas, and old growth (Personal conversation with Dr. Reynolds; Dailey et al 2008; work experience on the NKRD). Massive wildfires like Bridger, Warm, Rodeo, and Wallow have burned extensive areas and reduced ecosystem services such as wildlife habitat, soil, and watershed protection. The Rodeo Fire burned over 460,000 acres in central Arizona and disrupted the hydrologic functioning on two watersheds in ponderosa pine forests with high and low severity (Folliott et al 2011).

Light commercial thinning treatments in old growth areas have advantages. The collaborative affirmed that moderate, commercial treatments in old growth would benefit forest health and resource attributes.

Table 12. FVS model run of thinning small trees up to 16" dbh in old growth areas.

```
 SIMULATION: BurCorlOGTFB16MAR2016
Source: BurCorlOGTFB16MAR2016.out 03-01-2016 14:22:14
** Stands were weighted by sampling weight (usually acres) in calculating the average
values.
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YEAR	TRSGT16	BAALL	SDIALL	CANCOVR	MORTREE	FUELLDZ	TI	CRBHT
2014	44.51	171.06	381.76	45.77	1.94	14.09	38.89	19.41
2018	45.29	175.04	386.95	47.91	2.20	20.05	177.92	37.27
2024	45.91	143.56	233.20	34.55	2.11	18.45	75.33	38.69
2034	45.78	150.12	240.27	35.93	2.10	18.07	74.82	38.99
2044	45.30	155.03	244.95	36.88	2.21	18.67	76.93	39.42
2054	44.86	158.81	248.05	37.70	2.52	19.50	77.85	38.83

The direct effect of light commercial treatments in old growth would be a reduction in trees per acre, basal area, and SDI. Timber volume would also result from the treatment. Conversely, the fuels metrics would have an increase in TI, crown base height, and snags (MORTREE). Basal area is still very high, 144 in 2024, and SDI is reduced to healthier condition, about 233, or 47% of max. There are 45 trees per acre > 16" dbh that are maintained, and tree mortality in snags averages between 2 – 3 per acre by 2054.

Old growth characteristics are sustained despite a commercial treatment. Canopy and downed woody material (FUELLDZ) are in acceptable ranges with the removal of ladder fuels and the improvement in torching index. Canopy base height also compares favorably to the FVS simulation in the nest stands.

Table 13. Average summary table results of thinning small trees up to 16” dbh in old growth areas.

FVS SIMULATION: BurCorlOGTFB16MAR2016
SIMULATION DONE: 03-01-2016 14:25:50

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2014	18	1036	171	382	125	92	6.9	5812	5400	31615	0	0	0	0	171	382	125	92	6.9	4	45	15	0.0
2018	22	1008	175	387	128	92	7.1	5932	5511	32309	863	713	613	2505	139	228	95	92	13.2	6	37	7	0.0
2024	28	143	144	233	98	92	13.5	5398	5069	30986	0	0	0	0	144	233	98	92	13.5	10	35	9	0.0
2034	38	139	150	240	102	93	14.0	5659	5308	32694	0	0	0	0	150	240	102	93	14.0	10	30	10	0.0
2044	48	135	155	245	106	93	14.5	5859	5490	34010	0	0	0	0	155	245	106	93	14.5	10	28	12	0.0
2054	58	130	159	248	108	94	15.0	6015	5634	35032	0	0	0	0	159	248	108	94	15.0	10	25	13	0.0
2064	68	126	162	250	110	94	15.4	6137	5753	35758	0	0	0	0	162	250	110	94	15.4	0	0	0	0.0

Similar to nest stands, aspen and oak are removed and sprouting turned off. This allows an accurate assessment of the residual average tree diameter and height, 13.5” and 92’ tall in 2024. The major trade-off with thinning from below and leaving a large amount of overstory trees is a reduction in tree growth from 45 cubic feet per year to 25 at the end of the modeling period. This is a logical direct effect of removing vigorous young trees and leaving the rest to compete with older, slower growing individuals. Ponderosa pine reaches the culmination of mean annual increment at about 120 years old, and steadily declines in growth in later life.

In summary, the light harvest in ponderosa pine old growth would directly result in:

- Greatly reduced trees per acre;
- Lower basal area and SDI;
- Increased average diameter and height;
- Saleable timber volume to offset the costs of small tree thinning;
- Maintenance of the large tree component;
- Higher wind speeds necessary to torch individual trees;
- More snags and CWD for wildlife; and
- Compositional diversity for enhanced fire resistance and tree resilience.

The indirect effects would be improved forest health with available light, moisture, and nutrients distributed to residual larger trees. With reduced ladder fuels and higher crown base height, the old growth areas would also be more resistant to crown fire, and resilient to insect and disease attack.

Matrix Thinning Areas in the Burnt Saddle Strata

There are about of 4,215 acres in BC for thinning throughout a diameter range to a target basal area of 80 sq. ft. per acre in ponderosa pine (BAPP). See Table 14 below for the FVS model run for stands in the Burnt Saddle strata. Basal area after treatment for ponderosa pine was achieved with about 5,500 board feet volume harvested per acre. Important metrics for fire resistance include TI, torch index, and CRBASHT, crown base height. Both are advantageous qualities of the treated areas; there would need to be winds in excess of 50 mph to move surface fire into the crowns due in part to the increase of crown base height to over 20 feet for half of the modeling period.

The basal area for all species represents a well-forested condition though may be higher than desired. The density of other species, notably oak and aspen, could be reduced with commercial and timber stand improvement thinning, and with prescribed fire. An example of thinning to about 70 sq. ft. per acre is shown in the photograph below.

Figure 9 Before and after pictures of commercial harvest in the Buck Lake area.

Table 14. FVS computed values for thinning to reduce PP basal area to about 80 sq. ft.

SIMULATION: BCMatrixThinTo80Mar2016
Source: BCMatrixThinTo80Mar2016.out 03-14-2016 07:43:31
** Stands were weighted by sampling weight (usually acres) in calculating the average values.

YEAR	SDI	TPA18	BAPP	BFHRVSTD	BAAFTER	TI	CRBASHT	MORTREE
2016	379.90	23.50	101.86	5541.41	127.66	53.54	17.49	1.78
2026	340.32	18.66	77.76	0.00	145.98	41.49	15.69	1.83
2036	367.26	20.68	83.82	0.00	163.99	51.54	18.30	2.15
2046	390.90	22.40	88.42	0.00	181.23	61.38	20.33	2.65
2056	411.59	23.61	91.56	0.00	197.71	68.67	22.34	3.15

2066	428.66	24.74	93.29	0.00	212.89	72.06	24.01	3.72

The results in the matrix stands after a controlled, prescribed fire further promote the desired conditions for BC. Direct effects and benefits include reduced basal area, all species, to 91 sq. ft. per acre and the SDI lowered to ~170 in 2026. Both metrics represent improved forest health, especially density at 38% of max SDI, or the lower range of site occupancy. There would remain a healthy population of trees > 18" dbh with average crown base height over 30' and torching index above 50 mph for the entire modeling period. Though tree mortality increases for two cycles after the burn, it drops to normal levels by 2046 at about 2 trees per acre.

Table 15. FVS computed values for thinning to basal area target followed by a prescribed fire.

SIMULATION: BCMatrixThinAndRXFireMar2016
Source: BCMatrixThinAndRXFireMar2016.out 03-15-2016 08:55:44
** Stands were weighted by sampling weight (usually acres) in calculating the average values.

YEAR	SDI	TPA18	TPAALL	BAPP	BFHRVSTD	BAAFTER	TI	CRBASHT	MORTREE
2016	379.90	23.50	1265.14	101.86	0.00	159.31	37.75	13.54	1.78
2018	383.58	23.82	1227.90	103.13	5524.90	130.68	51.85	17.68	1.86
2020	320.99	17.72	1101.62	72.98	0.00	134.44	91.01	30.21	7.40
2026	169.88	17.12	208.52	66.98	0.00	91.39	52.78	31.61	5.24
2036	188.44	19.00	203.90	73.87	0.00	104.26	53.98	31.03	3.12
2046	205.08	21.09	199.12	79.07	0.00	116.28	58.17	31.68	2.14
2056	220.11	22.84	193.77	82.90	0.00	127.65	68.22	32.89	2.29
2066	233.49	24.64	187.64	85.40	0.00	138.32	74.83	34.19	2.55

The indirect effects of thinning and burning include improved forest health. Due to lower basal area and SDI and less competition, there would be more sunlight, moisture, and nutrients available to residual trees. Also, the remaining trees would have higher base heights and torching indexes for greater fire resistance, and better potential for ground fire. There would also be greater resilience to insect attack.

The better the host vigor, the greater tree defense to kill beetles by drowning or immobilization in resin when adequate moisture, oleoresin flow, and exudation pressure exists. Stressed trees (from drought, fire, inter-tree competition, or disease) are susceptible to attack, especially by *Ips* and *Dendroctonus species*. When individual trees have sufficient resources (light, nutrients, moisture), vigorous individuals are more likely to fend off beetle attacks (DeGomez et al, 2008). The proposed thinning treatments would improve tree health and resistance to disturbance such as bark beetle colonization.

Matrix Thinning Areas with Group Selection Patch Cuts

The remaining matrix areas include the rest of BC proposed for thinning to a basal area target. There are about 8,420 acres mostly in the Lookout Canyon and Pine Hollow areas. These acres include about 10% patch cuts from .5 – 3 acres in size. These areas would have young forest on about 900 acres with planned natural regeneration. On group selection cuts over 2 acres, we propose to leave 5 seed trees per acre with desirable phenotypic and genotypic traits, especially straight boles, fine limbs, and disease-free. See Appendix G for examples of openings created by patch cuts.

The following table shows the direct effects of commercial thinning and subsequent prescribed fire with summary statistics for the treated area. Sprouting was turned on, and the reduction in ponderosa pine basal area from 99 to 66 after treatment shows the effects of removing excess trees. The stands retain 18 trees per acre over 18" dbh after 20 years with both commercial harvest and controlled fire. Direct effects include increased

tree health and vigor as competing trees are removed, and SDI drops from 376 (75% - self-thinning) to 170 (34% - full site occupancy). The fire potential metrics recover with torch index increasing from 39 mph to 57 mph in 2036. Crown base height is lifted from 13' to 30' after 20 years. Controlled burning would be safe and effective at regular intervals into the future.

There would be about 5,000 board feet per acre of log volume directly produced from tree harvest. Again, the sale of commercial timber would provide revenues to the Forest and help offset costs of TSI, prescribed burning, and managed wildfires.

The aspen component would not be mechanically cut, but the prescribed burn would cause some mortality. There would be aspen and oak sprouting and growth response to surface fire, and removal of small, excess conifer trees. Treatments to maintain forest health and fire resilience would be recommended every 20 years.

Table columns: TPA18 = trees per acre > 18" dbh; BAPP = basal area in ponderosa pine; MORTY = mortality in trees per acre; BFHRVSTD = board feet harvested; BAAFTER = basal area after treatment; TI = torch index; CRBASHT = crown base height; and MORTREE = snags per acre at least 12" dbh and 15' tall.

Table 16. FVS computed values for thinning to a basal area target followed by a prescribed fire.

```
SIMULATION: BCMatrixLOCynThinAndRXFireMar2016
Source: BCMatrixLOCynThinAndRXFireMar2016.out 03-15-2016 15:39:03
** Stands were weighted by sampling weight (usually acres) in calculating the average values.
```

YEAR	SDI	TPA18	TPAALL	BAPP	MORTY	BFHRVSTD	BAAFTER	TI	CRBASHT	MORTREE
2006	326.28	19.68	1213.88	86.95	3.73	0.00	133.67	40.77	13.32	1.65
2016	368.86	21.45	1156.89	97.42	5.92	0.00	157.12	39.23	13.07	1.43
2018	376.03	21.83	1137.37	98.99	9.80	4969.27	126.79	55.50	16.19	1.42
2020	312.21	16.16	1019.09	65.82	6.55	0.00	131.71	95.09	27.58	6.59
2026	169.68	15.71	211.32	60.10	114.82	0.00	91.13	51.93	29.69	4.55
2036	189.84	18.16	206.83	66.71	3.96	0.00	105.14	57.04	29.91	2.60
2046	208.63	20.79	202.27	71.91	5.28	0.00	118.70	64.53	31.02	1.76
2056	226.49	23.28	197.61	75.93	6.53	0.00	132.05	69.30	31.53	1.86
2066	242.98	25.57	192.67	78.73	8.76	0.00	144.87	77.89	33.01	2.15

The indirect effects discussed above in the Burnt Saddle Matrix apply to these stands as well. Improved forest health would result in greater tree vigor and resistance to biotic disturbance agents. Treated stands would also have more openings, less tree density, and better resistance to stand-replacing wildfires.

Within the Matrix areas, there would be about 900 acres of group regeneration cuts planned across the project area. These patch cuts would range from .5 to 3 acres in size and would be strategically placed to increase composition diversity, open dense canopy for fire resilience, and promote uneven-aged forest condition. Natural regeneration would be monitored to ensure desired stocking in ponderosa pine, aspen, and oak.

When patch cut openings exceed 2 acres, about 5 seed trees per acre would be left to disperse ponderosa pine seed on the site. Seed trees would be superior in appearance and genetics favoring insect and disease free stock with excellent form and healthy, robust crowns.

See the FVS average summary table below for statistics of proposed group selection treatments.

Table 17. Average summary statistics for implementing group selection, or patch cuts, in BC.

FVS SIMULATION: BCPatchCuts1MAR2016
SIMULATION DONE: 03-28-2016 14:35:21

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2010	0	1321	112	295	86	76	4.0	3537	3269	18459	0	0	0	0	112	295	86	76	4.0	4	47	4	0.0
2014	4	1301	118	307	90	77	4.1	3708	3427	19342	0	0	0	0	118	307	90	77	4.1	4	49	5	0.0
2018	8	1278	125	320	97	78	4.3	3883	3585	20245	1022	2773	2581	14745	39	92	33	44	5.3	6	30	1	0.0
2024	14	1143	49	149	42	47	2.8	1286	1148	6323	0	0	0	0	49	149	42	47	2.8	10	44	2	0.0
2034	24	1124	76	210	70	52	3.5	1710	1426	7739	0	0	0	0	76	210	70	52	3.5	10	51	4	0.0
2044	34	1103	103	268	99	57	4.1	2186	1703	9090	0	0	0	0	103	268	99	57	4.1	10	65	7	0.0
2054	44	1068	133	326	128	60	4.8	2763	2038	10372	0	0	0	0	133	326	128	60	4.8	10	79	15	0.0
2064	54	981	158	369	153	64	5.5	3401	2566	11320	0	0	0	0	158	369	153	64	5.5	10	96	21	0.0
2074	64	906	183	408	177	68	6.1	4151	3471	12225	0	0	0	0	183	408	177	68	6.1	0	0	0	0.0

The direct effects of the patch cuts would be reduced basal area from 125 sq. ft. per acre to 39, and timber harvest, about 14.75 mbf per acre. The SDI values improve from self-thinning to stand-initiation condition, from 61% to 18% of max. Though trees per acre remain high, most are due to natural regeneration and sprouting in the oak and aspen clones. Young aspen and oak would be fire resistant as well.

The indirect effects of having available light, moisture, and nutrients with minimal competition would be healthy stands resistant to crown fire. Mortality remains low, 1 – 7 cubic feet per acre until 2044, as growth doubles to 65 cubic feet per acre. When basal area and SDI increase to self-thinning levels, a controlled surface fire would be recommended after 2044 to remove excess trees per acre, especially oak and aspen. Established ponderosa pine would be fire resistant by then and able to survive a prescribed ground fire.

Mexican Spotted Owl Strata

There are about 360 acres in the southeast portion of BC that constitute MSO habitat. The proposed action would thin from below to 12" dbh. There are about 160 acres on steep slopes that we would avoid with logging equipment yet we can thin densely stocked stands from below to improve forest health, reduce ladder fuels, and stimulate aspen and oak sprouting. Benefits to wildlife would be greater mast and forage for prey species, and reduced risk of hazardous wildfire.

See table below of the direct result of thinning in 2018 with subsequent controlled fire in the MSO stands.

Table 18. Average summary statistics for thinning from below in MSO habitat.

FVS SIMULATION: BCMsoTFB12MAR2016
SIMULATION DONE: 03-22-2016 11:59:26

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
1995	0	1806	122	335	119	78	3.7	3437	3019	15107	0	0	0	0	122	335	119	78	3.7	9	95	11	0.0
2004	9	1708	152	396	153	81	4.2	4188	3660	18157	0	0	0	0	152	396	153	81	4.2	10	103	18	0.0
2014	19	1589	184	453	189	84	4.8	5050	4389	21645	0	0	0	0	184	453	189	84	4.8	4	110	20	0.0
2018	23	1545	198	477	205	85	5.0	5408	4686	23031	1186	178	0	0	183	339	178	85	9.6	6	74	147	0.0
2024	29	180	152	256	139	86	12.4	4795	4397	22973	0	0	0	0	152	256	139	86	12.4	10	85	5	0.0
2034	39	176	175	285	160	88	13.5	5592	5134	27255	0	0	0	0	175	285	160	88	13.5	10	89	6	0.0

2044	49	172	198	312	180	91	14.5	6416	5951	31540	0	0	0	0	198	312	180	91	14.5	10	92	13	0.0
2054	59	166	218	335	198	93	15.5	7208	6729	35715	0	0	0	0	218	335	198	93	15.5	10	94	17	0.0
2064	69	160	237	355	213	95	16.5	7968	7477	39669	0	0	0	0	237	355	213	95	16.5	10	93	21	0.0

*STANDS WERE WEIGHTED BY SAMPLING WEIGHT (USUALLY ACRES.)
**REMOVAL AVERAGES ARE BASED ON VALUES FROM ALL STANDS, INCLUDING THOSE IN WHICH ZERO VOLUME WAS HARVESTED THAT CYCLE.

Note well: sprouting was turned off for this model run to better illustrate the direct effects of thinning and controlled burning.

Small trees and SDI were reduced considerably; from 1545 to 180 per acre, and 477 to 256. The reduction of SDI was impressive; from 68% to 37% of max (700 SDI_{max} in mixed conifer). This is reflected in mortality decreasing from 20 cubic feet per acre before to 5 per acre after treatment in 2024. Accretion or growth improved to 89 in 2034, and that is excellent wood production for the NKRD. Another series of thinning and burning activities would be warranted by 2054 when SDI, merchantable volume per acre, and mortality increase to high levels. With greater growth concentrated on healthy, residual trees, the mean diameter per acre rose from 5.0” in 2018 to 12.4” in 2024.

The following table shows other important metrics for habitat and fire potential. Both treatments improved fire resistance by increasing torching index winds from 3 mph in 2014 to 35 mph in 2018. The crown base height is very low in mixed conifer because shade tolerant trees retain their lower branches as they age. Both thinning and controlled fire quadrupled height to live crowns by 2024.

Canopy cover and basal area concentrated in larger trees is beneficial for MSO habitat. Even after treatments, the basal area in 2034 was concentrated in trees > 12” dbh; 141 sq. ft. per acre, or 80% of total. Overstory canopy cover was 46% after treatment and increased to 57% at the end of the modeling period. With less competition from residual trees and faster growth, trees over 18” dbh increased from 24 in 2018 to 34 trees per acre by 2044. These direct effects validate the efficacy of successful mechanical and fire treatments in MSO habitat.

Table 19. Computed values of habitat features in MSO areas with thinning from below.

SIMULATION:BCMsoTFB12MAR2016
Source: BCMsoTFB12MAR2016.out 03-22-2016 11:54:03
** Stands were weighted by sampling weight (usually acres) in calculating the average values.

BA1218 = basal area in trees 12 – 18” dbh; COVALL = canopy cover; CRBASHT = crown base height.

YEAR	BA1218	BA1824	BA24UP	TPA18UP	BAALL	COVALL	TI	CRBASHT	SNG14ALL	DOWNWD
1995	24.27	23.77	25.79	16.16	121.56	50.96	12.85	3.32	4.83	0.00
2004	26.55	25.56	36.61	19.87	151.90	62.67	10.77	4.08	2.69	0.59
2014	36.95	28.55	46.42	23.06	183.80	69.59	3.15	2.60	2.53	0.96
2018	39.81	30.30	49.17	24.36	182.55	59.58	35.15	12.10	7.38	0.88
2024	36.71	31.49	49.91	24.66	152.41	46.32	27.66	12.34	5.13	1.80
2034	41.26	40.82	58.51	30.47	175.17	49.93	31.02	14.26	2.91	2.78
2044	49.85	46.28	68.06	33.94	197.69	53.02	41.74	15.91	2.11	3.21
2054	54.55	54.53	78.28	39.64	218.13	55.32	47.65	17.78	2.51	3.37
2064	55.35	61.41	91.14	45.82	236.93	57.21	50.44	19.02	3.32	3.63

Though improved forest health is an indirect effect of thinning and burning, the increased growth eventually results in very high basal area by 2044. To avoid a major disturbance event such as wildfire, bark beetle attack or disease, another round of treatments would be recommended in 2044 to maintain quality MSO habitat and prevent substantial mortality.

See the results of a modeled wildfire below.

Table 20. A table of computed values in MSO habitat before and after a modeled wildfire.

```
SIMULATION:BCMsoTFB12WfireMAR2016
Source: BCMsoTFB12WfireMAR2016.out  03-22-2016  14:10:19
** Stands were weighted by sampling weight (usually acres) in calculating the average values.
```

YEAR	BA1218	BA1824	BA24UP	TPA18UP	BAALL	COVALL	TI	CRBASHT	SNG14ALL	DOWNWD
1995	24.27	23.77	25.79	16.16	121.56	50.96	12.85	3.32	4.83	0.00
2004	26.55	25.56	36.61	19.87	151.90	62.67	10.77	4.08	2.69	0.59
2014	36.95	28.55	46.42	23.06	183.80	69.59	3.15	2.60	2.53	0.96
2018	39.81	30.30	49.17	24.36	182.55	59.58	35.15	12.10	7.38	0.88
2024	36.71	31.49	49.91	24.66	152.41	46.32	27.66	12.34	5.13	1.80
2034	41.26	40.82	58.51	30.47	175.17	49.93	31.02	14.26	2.91	2.78
2044	49.85	46.28	68.06	33.94	197.69	53.02	41.74	15.91	2.11	3.21
2045	50.08	47.77	68.48	34.73	199.90	53.31	171.87	57.95	39.06	2.05
2054	8.37	23.03	41.13	18.58	75.12	18.31	86.07	61.07	21.69	8.93
2064	7.21	21.97	49.72	19.95	81.14	19.46	86.30	62.24	11.05	13.05

A severe crown fire in 2045 would debilitate MSO habitat. The canopy cover would be < 20% and the only survivors would be large trees. Crown base height would be about 60’ meaning there are few if any young trees in the understory. The stand would not be sustainable as the older trees die out, eventually replaced with aspen and oak. Tree planting would be necessary to establish desired ponderosa pine and Douglas-fir on the sites.

3) Cumulative effects.

The current plan for the Burnt Corral area would be to use commercial thinning, patch cuts to create canopy gaps, timber stand improvement, and burning in this entry. Eventually, there would be a need to re-enter the area in about 25 years for site-specific management (mechanical or fire) where necessary. Given this time frame, the Cumulative Effects period for analysis is 25 years into the past, and 25 years into the future. The cumulative effects area encompasses the BC project area and surrounding forest.

Planned, present and foreseeable actions include the implementation of the Plateau Facilities Fire Protection Project (PFFPP) and Jacob-Ryan in the Jacob Lake vicinity. These two project areas contain about 30,000 acres. There would be mechanical thinning (commercial and precommercial) on about 20,000 acres; not all of these acres are suitable for commercial thinning. This project would also include prescribed burning on over 25,000 acres, and would add these acres as improved forest health with reduced fire hazard.

Both the Plateau Project and Jacob-Ryan are primarily in ponderosa pine type and would encompass cumulative effects related to Burnt Corral. Presently, there have been about 3,500 acres of commercial harvest in Jacob-Ryan and PFFPP that have cumulatively reduced the risk of high-intensity stand replacing wildfires by creating gaps in the canopy, reducing live fuel loads, and decreasing ladder fuels.

There have also been about 3,700 acres of small tree thinning and hand-piling in JR and PFFPP. These actions have reduced trees from 1’ to 8.9” dbh from over 400 per acre to about 100 – 120 trees per acre. This has reduced ladder fuels, removed dog-hair thickets, opened the forest floor, and resulted in the growth of grasses, forbs, and shrubs in the understory. As more openings have been created, the risk of hazardous and destructive crown fires has been mitigated by restoring the Historical Range of Variation when most fires in these ponderosa pine systems were cooler, surface burns with little or no crown torching.

Other actions planned and completed in the Cumulative Effects Analysis Area include prescribed burning, and managed wildfires for resource benefit.

During 2015, there was a managed wildfire in the BC project area called the Burnt Complex. This fire occurred in the south and central part of BC west of FR 422, and was contained in the management area at 3,900 acres. The effects of the fire was to reduce small trees per acre, consume heavy fuels on the forest floor, and stimulate aspen sprouting. Overall, the fire benefitted the area by decreasing the risk of a stand-replacing wildfire. The past timber treatments described below gave fire managers the opportunity to let this wildfire burn.

The Moquitch RX burn was completed in 2018 - 2019 on about 2,500 acres. This project added those acres for improved forest health, wildlife habitat, and fire hazard reduction. Moquitch is a 10,000 acre project area in ponderosa pine type and occupies the forest east of FR 462 and north of FR 212 just south of Jacob-Ryan. District personnel have completed most of the controlled fire in the area. The additive benefit of controlled fire on almost 10,000 acres in the ponderosa pine type located strategically south of the Jacob Lake resort area was fire resistance and resilience in valuable stands of pine and aspen.

There is a landscape-scale project planned on the NKRD called the Kaibab Plateau Ecosystem Restoration Project. This ambitious decision would implement prescribed burning and vegetation management of small trees across the District. The area of this project applicable to the Burnt Corral Cumulative Effects area would be the ponderosa pine type surrounding Burnt Corral and extending to the north end of the district, about 127,000 acres. Over time, there would be a cumulative benefit of restoring fire resilience, improving forest resiliency, increasing stand health and vigor, and sustaining aspen clones. These controlled burns would be planned for the next 25 years and would greatly increase the restoration effort on the NKRD.

The cumulative benefits of the past timber sales in Burnt Corral (Burnt Saddle, Pine Hollow, Lookout) include the ability to promote surface fire, to open dense stands, and to provide fuel breaks. These treatments covered about 9,620 acres, including even-aged regeneration treatments that have established young forest. There were intermediate thinning treatments on about 85% of the acres commercially harvested. The cumulative benefits from past management include gaps and open areas where crown fire would drop to the surface.

Planned mechanical treatments in BC would include up to 16,200 acres of commercial harvest. By reducing high basal areas to Forest Plan guidelines, personnel from the NKRD would reduce the risk of destructive crown fire, improve forest health, increase the aspen and oak components, and create openings on up to 900 acres. These cumulative benefits would include a more diverse forest structure with a greater range of tree age classes, and the promotion of uneven-aged stands; a clear objective in the Forest Plan.

The Proposed Action in the Burnt Corral project area would not reduce any acres of old growth as thinned trees would be less than 16” dbh, and the controlled, surface fire would retain most trees in the mid to upper canopy layers. Incidental mortality would be very minimal. There are currently about ~2,180 acres in Burnt Corral with old-growth characteristics of large trees, substantial canopy cover, and snags. Ecosystem services provided in old growth areas would be maintained.

There was also salvage logging and reforestation on about 1,360 acres in the Bridger Fire burn area. The cumulative effects of these activities include established advanced regeneration, and a future benefit of ponderosa pine seed sources in the burned area. This potential timber and seed crop will be protected from managed and unmanaged wildfires.

See BC cumulative effects of timber cut units and plantations in Appendix C.

There were about 1,130 acres of ponderosa pine forest thinned and hand-piled in the Westlake area. This was small tree thinning of conifer trees from 2' to 8.9" dbh. The slash was hand-piled by 2009, and the piles were burned several years later. This treatment removed small tree density, and reduced some ladder fuels. Westlake would have commercial harvest yet will not be available for TSI in the BC project implementation phase.

Adjacent to BC on the southwest boundary was the Big Saddle thinning and lopping project. This area is about 565 acres where ponderosa pine was cut from 2' to 8.9 inches dbh. This is another block of forest near BC that has reduced fire hazard and improved conditions for growth and fire resistance post-treatment.

By moving the Burnt Corral area to a more fire-adapted ecosystem, and reducing the high density of trees per acre to more historic conditions, we would be reducing the risk of stand-replacing wildfire as occurred in the Warm Fire Suppression area. With improved site and vigor conditions for larger, fire-resistant ponderosa pine and Douglas-fir trees, we would provide a cumulative benefit by maintaining seed trees for future reforestation projects. The occurrence of fire in both types is less frequent, yet can be a stand-replacement event. The benefit of the proposed action in all vegetation types would be the reduction in fire hazard, and the ability to protect important habitat features such as old growth.

See table below for summary of cumulative effects.

TYPE	PAST ACTIONS	PRESENT ACTIONS	PROPOSED ACTIONS	FUTURE ACTIONS	CUMULATIVE EFFECTS
TSI in project area	Thin/Pile				1,130 acres restored to fire resilience
Harvest in BC	Commercial treatment				9,620 acres reduced basal area and fuels
TSI in PFFPP/JR		Thin/Pile			3,700 acres restored to fire resilience
Harvest in PFFPP/JR		Commercial treatment			3,500 acres reduced BA and fuels
Fire in BC	Managed wildfire for resource benefits				3,900 acres of reduced fuels and trees per acre
Fire in ponderosa pine type			Prescribed Fire		20,000 acres per year to restore fire-adapted ecosystems
Fire in ponderosa pine type in KPERP				Prescribed Fire	Up to 127,000 acres of restored ponderosa pine type
TSI in BC			Small tree		Up to 14,500

			thinning		acres of reduced BA and ladder fuels
Harvest in BC			Commercial treatment		Up to 17,400 acres of restored ponderosa pine type
RX fire in Moquitch	Prescribed Fire				10,000 acres added to resilient ponderosa pine forest

Terms and definitions:

BA	Basal area in square feet per acre.
BC	Burnt Corral Vegetation Management project.
Commercial Treatment	Harvest of trees usually greater than 9" dbh.
KPERP	Kaibab Plateau Ecosystem Restoration Project.
Managed wildfire	Wildfires from natural starts allowed to burn.
Moquitch	CE decision for mostly prescribed burning.
Prescribed Burn	Controlled fire mostly on the surface for restoration.
Small Tree Thinning	Cutting small trees from 1' to 8.9" dbh.
Thin/Pile	Cutting and handpiling small trees up to 8.9" dbh.
TSI	Timber Stand Improvement thinning.

VI) COMPLIANCE WITH LAWS, REGULATIONS AND POLICY

National Forest Management Act

Because this EA involves vegetative management treatments NFMA compliance items covered under 36 CFR 219.12, Forest Service Manual (FSM) 1921.14, FSM 1921.12, and Forest Service Handbook 1909.12 will be summarized below.

FSM 1921.14 – Guidelines

Plans shall include guidelines as part of the design criteria that help achieve the objectives and desired conditions. The language of guidelines and their organization in a plan should be constructed to convey the circumstances to which the guidelines apply. Compliance with a guideline must be written within the agency's discretion to control the relevant factors that make it possible to adhere to the requirement.

Response: The Proposed Action alternative complies with Forest Plan Standards and Guidelines (S&Gs). The Forest Plan S&Gs are a product of the Regional guides, and these S&Gs were developed specifically for the Kaibab National Forest. Additionally, project design criteria would be developed to address site specific resource concerns within the project area.

FSM 1921.12a–Timber Management Requirements

Under 16 U.S.C. 1604 (g)(3)(E), a Responsible Official may authorize site-specific projects and activities on NFS lands to harvest timber only where:

1. Soil, slope, or other watershed conditions would not be irreversibly damaged.

Response: SWCPs (Soil and Water Conservation Practices) implemented in project design and contract initiation is designed to minimize impacts to site productivity and ensure conservation of soil and water resources. These are discussed in the Soils and Water report. Contract clauses would be used that implement SWCPs, such as directional felling, and designated skid trails.

2. Wetlands, and other bodies of water are protected from detrimental changes in water temperatures, blockages of water courses, and deposits of sediment where harvests are likely to seriously and adversely affect water conditions.

Response: The analysis of the Proposed Action shows that there would be no change to water quantity in any of the affected watersheds. Affects to water quality would be negligible due to the implementation of the required SWCPs.

3. The harvesting system to be used is not selected primarily because it would give the greatest dollar return or the greatest unit output of timber.

Response: While economics and outputs were considered in the decision process, other factors related to reducing the impacts of wildfire, insects and diseases, and protection of resources within the project area as described in the EA would be the primary focus to determine the best action to implement. The reasons for the decision would be fully described in the Decision Notice.

A Responsible Official may authorize projects and activities on NFS lands using cutting methods, such as clearcutting, seed tree cutting, shelterwood cutting, and other cuts designed to regenerate an even-aged stand of timber, only where:

1. For clearcutting, it is the optimum method; or where seed tree, shelterwood, and other cuts are determined to be appropriate to meeting the objectives and requirements of the relevant plan (16 U.S.C. 1604 (g)(3)(F)(i)).

Response: No clear-cut and plant treatments are currently being proposed in the project area. Any group selection patch cuts would be three acres or less.

2. The interdisciplinary review has been completed and the potential environmental, biological, aesthetic, engineering, and economic impacts have been assessed on each advertised sale area and the cutting methods are consistent with the multiple use of the general area (16 U.S.C. 1604 (g)(3)(F)(i)).

Response: The individual specialist reports contained in the EA address these requirements.

3. Cut blocks, patches, or strips are shaped and blended to the extent practicable with the natural terrain (16 U.S.C. 1604 (g)(3)(F)(iii)).

Response: The proposed treatments areas are located within the natural terrain features of the project area.

4. Cuts are carried out according to the maximum size limit requirements for areas to be cut during one harvest operation (FSM 1921.12e).

Response: Opening sizes would not exceed the maximum size allowed.

5. Timber cuts are carried out in a manner consistent with the protection of soil, watershed, wildlife, recreation, esthetic resources, cultural and historic resources, and the regeneration of the timber resource.

Response: The effects on each resource are disclosed in the EA. The effects of implementing the proposed action would have not long-term adverse effects on the affected resources.

FSH 1909.12, Chapter 60, section 62 – Identification of Generally Suitable Land Use for Forest Vegetation Management

Response: Lands proposed for timber harvest within the project area have been reviewed in the field and were determined to be suitable for timber production. Some areas were determined to be non-suitable due to slope, forest type, or soils.

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This Resource Specialist report was completed utilizing the best available science, a consideration of responsible opposing views, and the acknowledgment of any incomplete or unavailable information, scientific uncertainty, and risk. The Environmental Analysis incorporates information from this Resource Specialist report. Based on my professional experience and judgment, I certify that this Resource Specialist report is to the best of my knowledge, complete, true and accurate.

Signed /S/ Garry Domis, Certified Silviculturist Date ***03/31/2016; updated 02/07/17; updated 9/09/2019; 3/04/2020***

APPENDIX A – Collaboration and Photography

This set of photographs was taken in the Burnt Corral area during field work, collaborative field trips, and monitoring.

Figure 10 Dense stand of blackjack timber in BC.

Figure 11 Collaboration group of Forest Service and stakeholders.

Figure 12 Small opening and the opportunity to increase aspen in BC.

APPENDIX B – Results of Large Wildfires

Figure 13 One year old aspen sprouts after the Sanford Fire, Dixie NF, Utah.

Aspen is a disturbance-dependent species that flourished when these western lands burned periodically. With suppression of this natural force, many of these lands have converted, or are in the process of converting, to other vegetation types, such as conifer (for example, subalpine fir) or sagebrush. Three of the most critical products being lost from the aspen system as a result of this conversion are water, undergrowth vegetation, and biodiversity (Bartos, 2007).

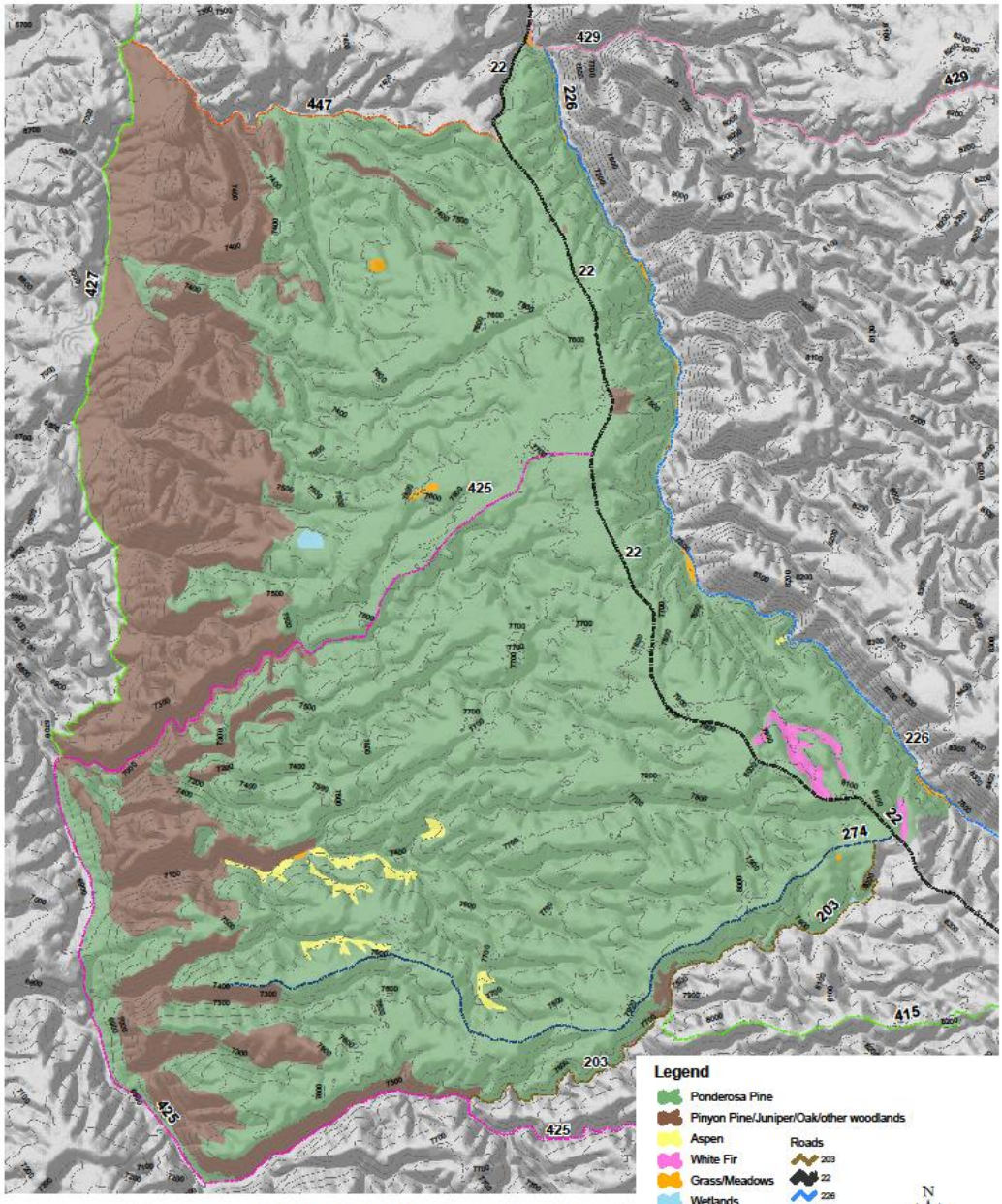
Similarly, 50 years of logging in the late 20th century led to a ten-fold increase in aspen recruitment, and lower rates of logging in the future would likely promote less aspen recruitment than in the late 20th century (Binkley et al, 2006).

Figure 14 Warm fire severity with complete mortality after 2006 wildfire.

APPENDIX C – Maps

Burnt Corral Vegetation Types

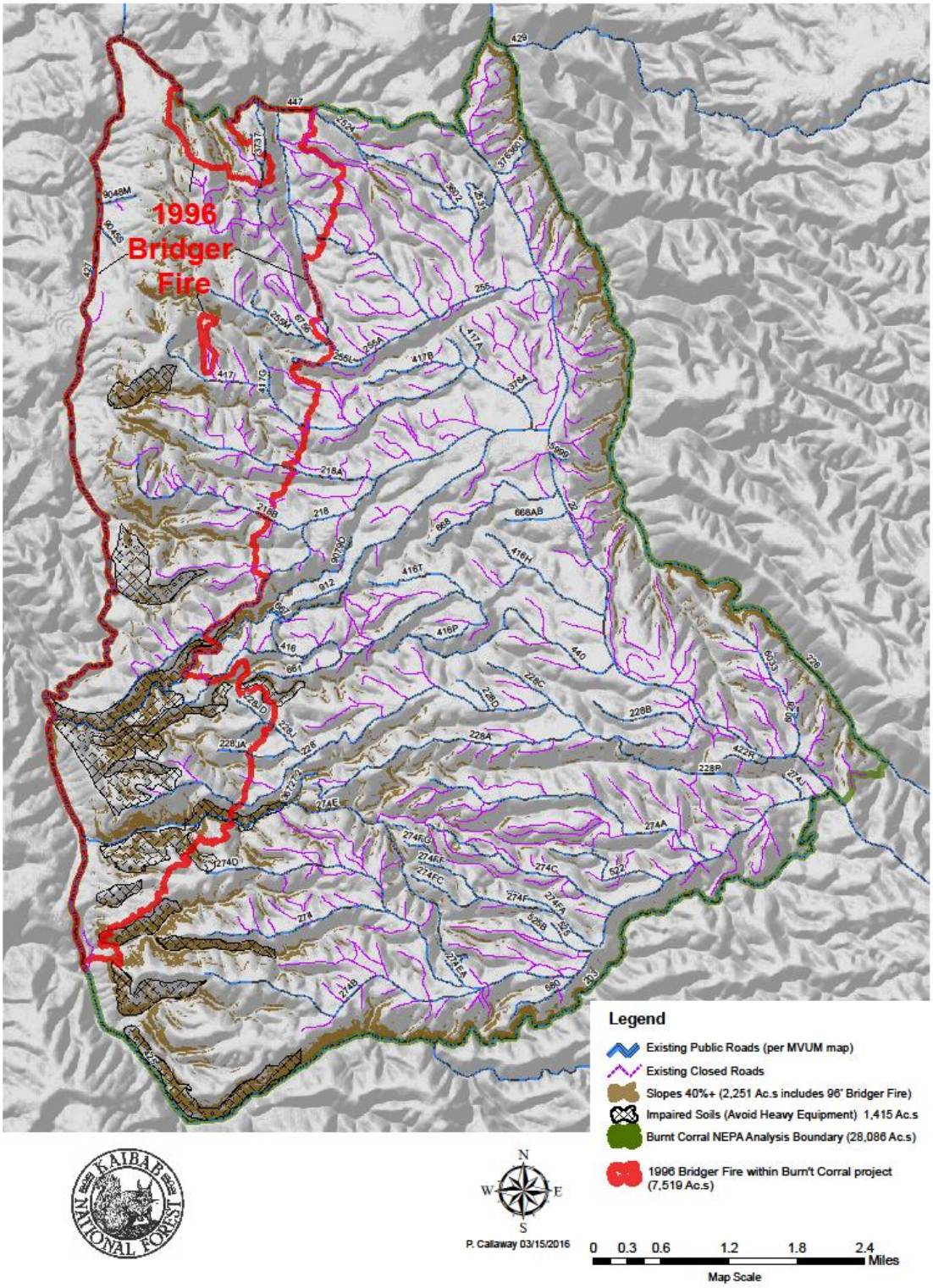
North Kaibab Ranger District
Kaibab National Forest



Primary Cover Type Acre Summary	Acres	%
Ponderosa Pine	21,202	75.5
Pinyon Pine/Juniper/Oak/otherwoodlands	6,532	23.3
Aspen	149	0.5
White Fir	110	0.4
Grass/Meadows	74	0.3
Wetlands	19	0.1
Total >>>	28,086	100.0

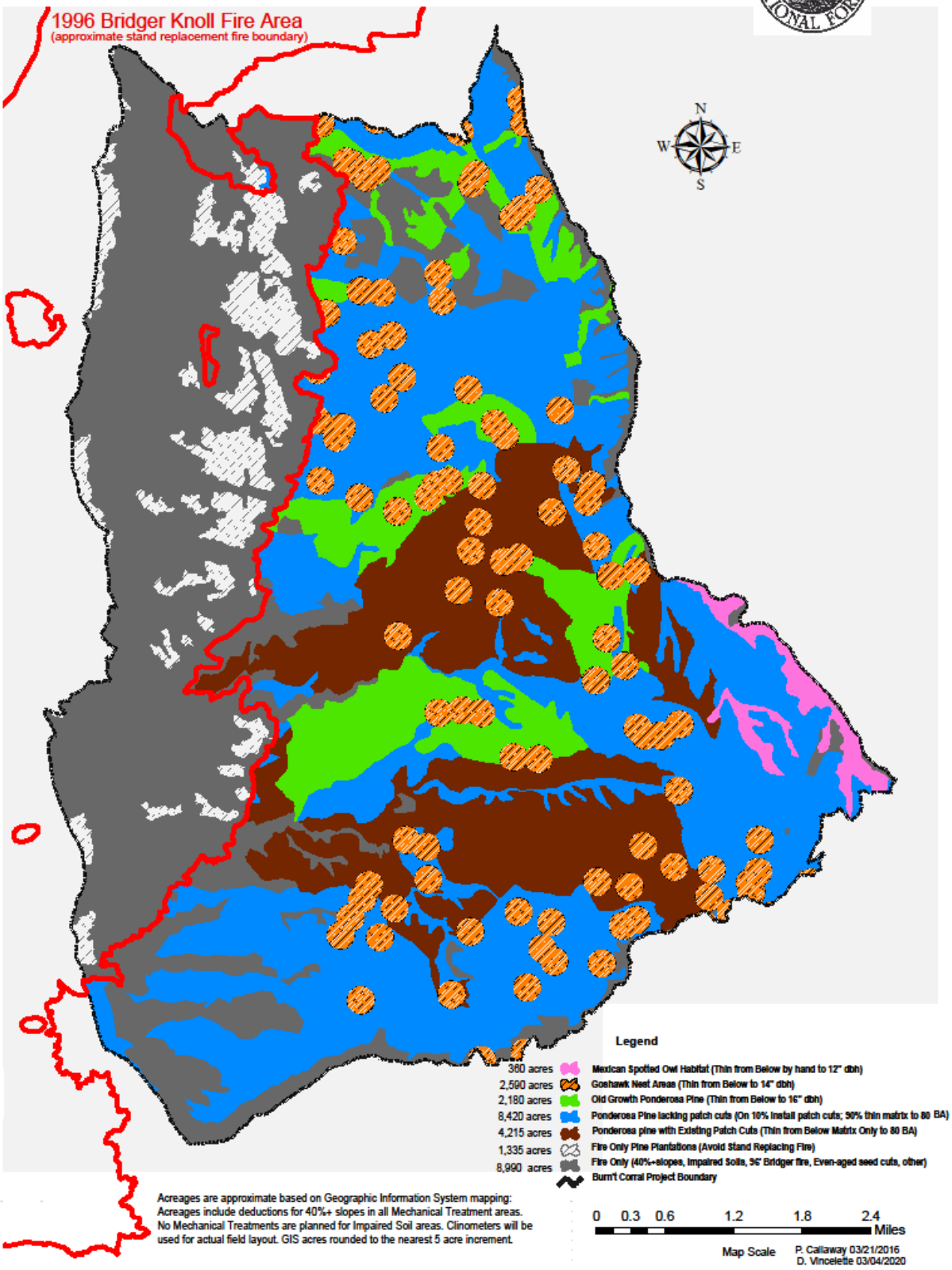
Burnt Corral: Roads, Slopes 40%+ & Impaired Soils

North Kaibab Ranger District
Kaibab National Forest

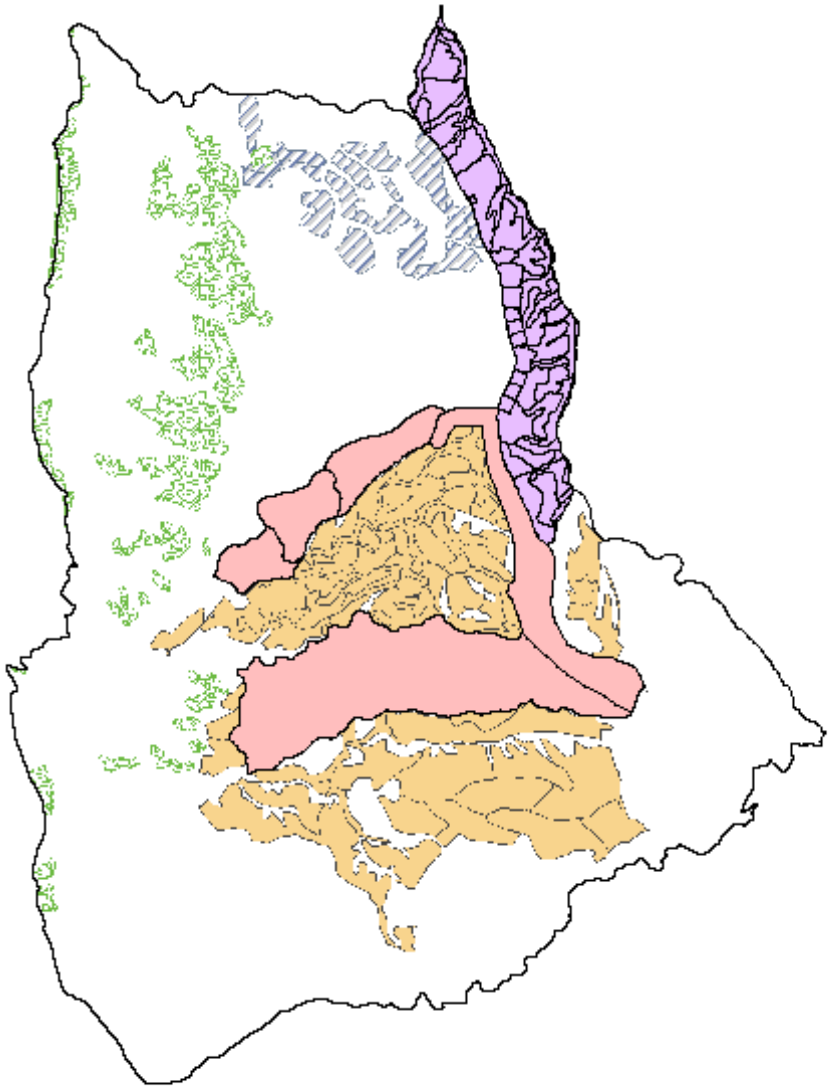


Burnt Corral Proposed Action Mechanical Treatments

Kaibab National Forest - North Kaibab Ranger District



Burnt Corral Project Area Past Timber Sales Salvage and Cut Units from 1990 - Present



Bridger -	1,366 acres
Pine Hollow -	692 acs.
Burnt Saddle -	7,438 acs.
Lookout -	1,487 acs.

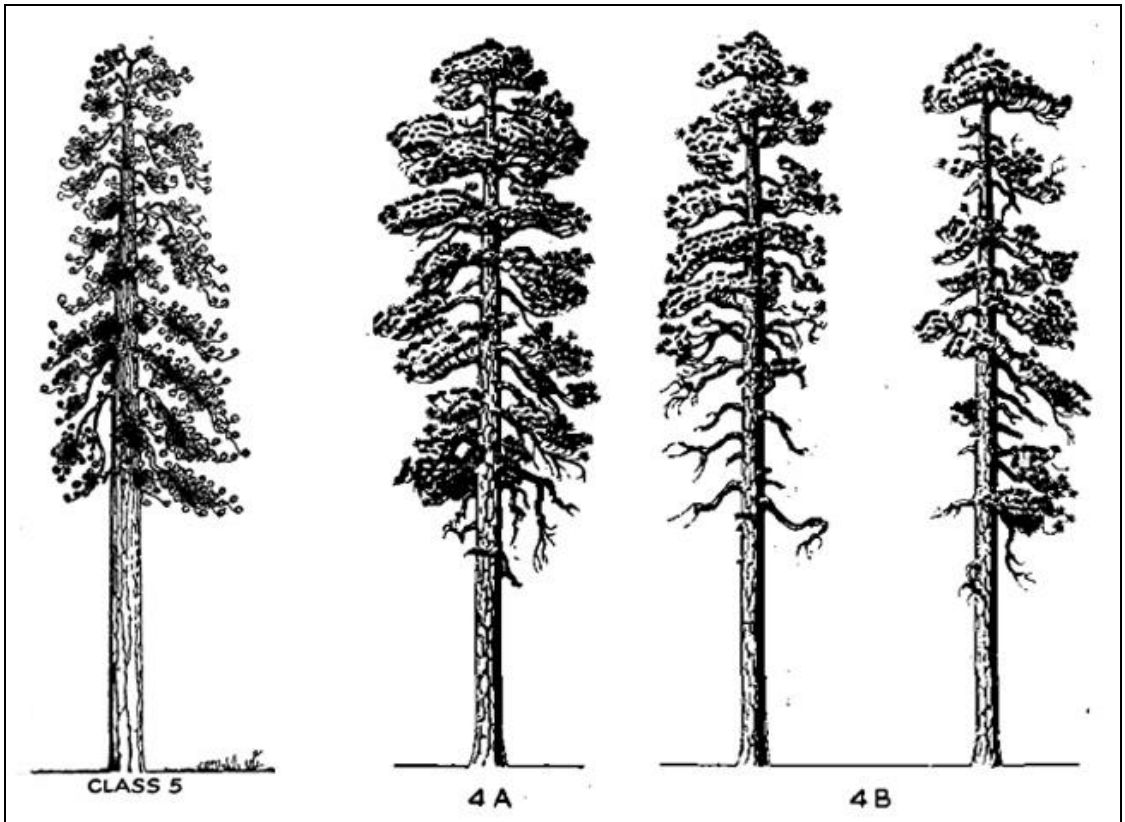
Legend

- Bridger Units and Plantations
- Burnt Saddle Cut Units
- Burnt Saddle Group Cut Units
- Lookout Canyon Cut Units
- Pine Hollow Cut Units

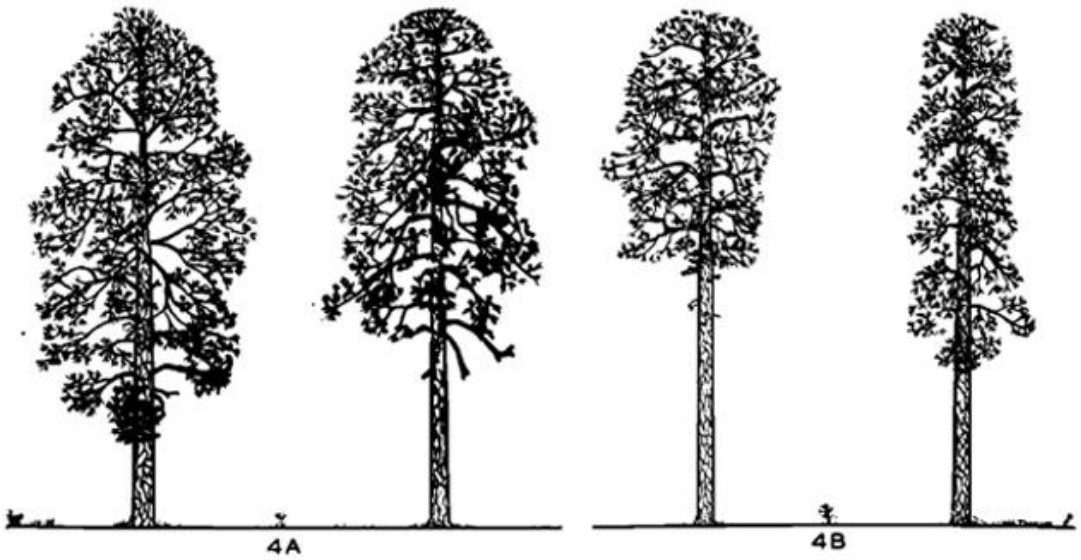
Prepared by:
Garry Domis - 3/29/16

0 0.5 1 2 Miles

APPENDIX D – Large Tree Retention Classes for Ponderosa Pine



Dunning Class 5 Keen Classes 4A and 4B



Thomson Classes 4A and 4B

Age Class Descriptions

Dunning (1928) Age Class 5: Overmature; usually largest trees in stand; bark light yellow with wide, long and smooth plates; tops flat with terminals rarely discernible; nearly all branches are drooping, gnarled, and crooked.

Keen (1943) Age Class 4: Overmature; making no further height growth; diameter growth very slow; bark light yellow, uniform for entire bole (except in extreme top), with wide, long and smooth plates and often shallow fissures; tops usually flat or occasionally rounded or irregular; branches large, heavy, and often gnarled or crooked and mostly drooping except in extreme top.

Thomson (1940) Age Class 4: Mature to overmature; trees usually large; bark reddish-brown to yellow with wide, long and smooth plates; tops usually flat and making no further height growth; branches mostly large and drooping, gnarled or crooked.

Determination of land that is suitable for timber production (1982 Rule, Section 219.14) and establishment of the allowable sale quantity (ASQ) of timber (1982 Rule, Section 219.16)

The analysis and discussion of lands suitable for timber production are found in Chapter 4 of the revised Plan. The land area designated suitable for timber production on the Kaibab National Forest totals 381,517 acres. The amount of wood that is estimated to be available for sale from the suitable land within the plan area for the first decade of plan implementation is called the allowable sale quantity (ASQ). The ASQ is better described as the "average allowable sale quantity" because it may be exceeded in a given year as long as the 10-year average is not exceeded. For this plan, the ASQ is 107,815 CCF (hundred cubic feet). This is a reduction from 152,300 CCF under the previous plan, which is due to the revised plan providing fewer acres of lands suitable for timber production, a shift from even-aged to uneven-aged management, and realistic, collaboratively developed acres and volumes to be treated annually. More information on timber suitability and ASQ is available in FEIS Appendix C.

APPENDIX E - Destructive Effects of Severe, Crown Fire

Figure 15 Extremely destructive crown fire with torching trees and dangerous flame lengths.

APPENDIX F– Commercial Thinning Treatments

Ongoing projects have seen very good results on the ground and the hazardous fire potential has been mitigated. See photograph below of active forest management on the projects near Jacob Lake.

Figure 16 Positive results from commercial harvest in Jacob Ryan with a more open canopy.

Figure 17 Removing small trees from dense ponderosa pine stands to improve vigor and forest health.

APPENDIX G - Group selection examples in the Burnt Saddle area